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Editors
SÁLIM ALI & H. SANTAPAU, S.J.

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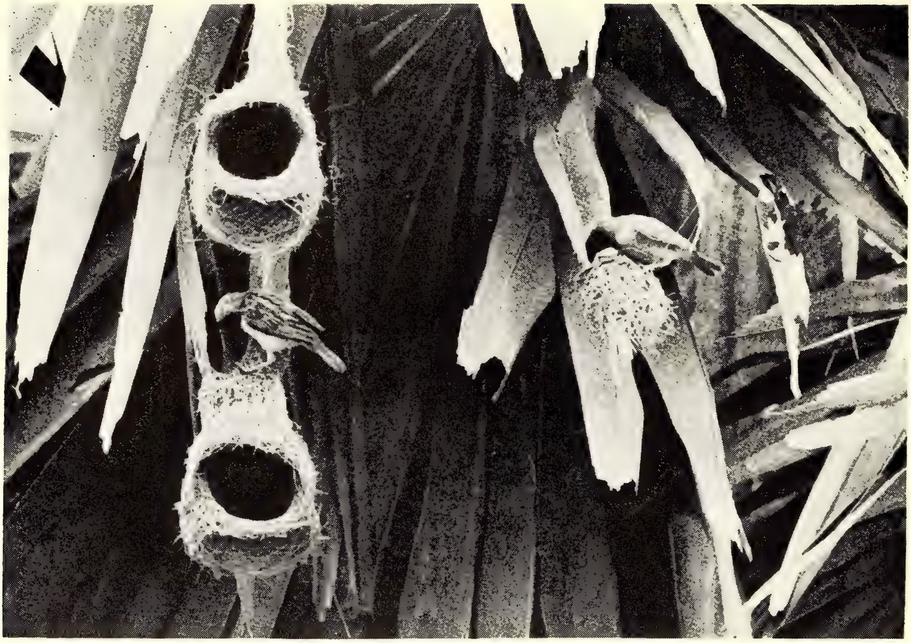
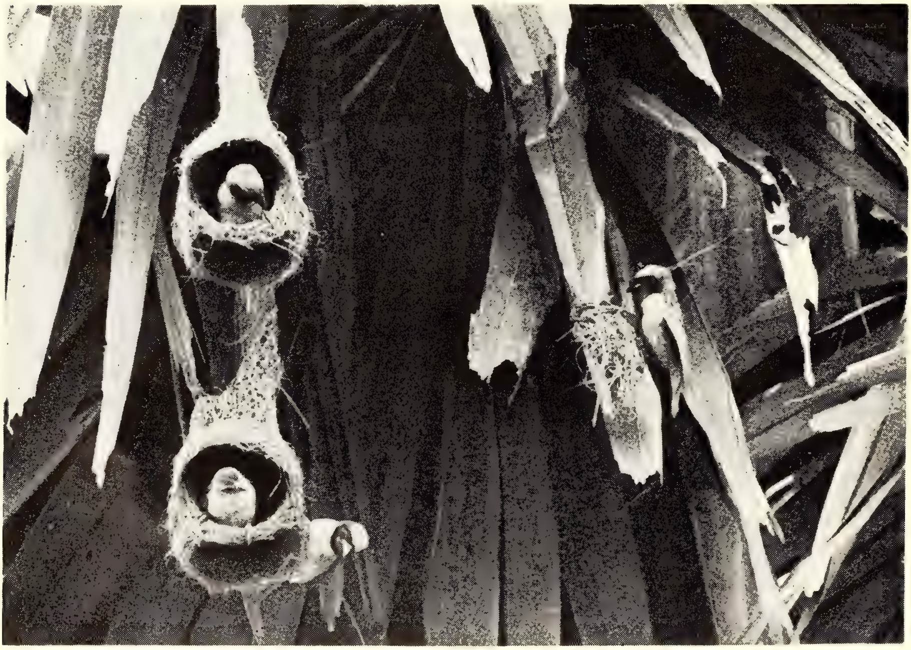


Nests in the 'bell' or 'helmet' stage ready for appropriation by hens. The cock on the right is reinforcing a new attachment.



A newly arrived hen perches on the cross-bar or 'chin-strap', while the cock clings and flutters excitedly on the outside.

Photos : Sálim Ali

JOURNAL

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1957 VOL. 54 NO. 3

FURTHER NOTES ON THE BAYA WEAVER BIRD, *PLOCEUS PHILIPPINUS* LINN.[1]

BY

SÁLIM ALI AND VIJAYKUMAR C. AMBEDKAR

(*With a plate*)

In the 1956 season our observations were carried out mainly in two localities:

1. The Poona area chiefly by VCA, with the help of a grant-in-aid from the Bombay Natural History Society, under the guidance and with the intermittent active participation of SA, and

2. The Bombay area by SA, mainly at a nest colony on a palmyra palm on the farm belonging to Shri J. A. Ali, situated near Devnar village along the main Chembur-Trombay Road.

1. The Poona Area

As last year, the study was carried out principally in the country around the base of Parbati Hill, about a mile SW. of Poona City. Our main Control Colony, conveniently situated for frequent inspection by day or night, contained some 9-11 nests suspended from lantana bushes and peepal trees growing out from within the sides of a well, or on branches that hung down into the shaft. The colony was sufficiently off the beaten track to be relatively safe from molestation by village urchins. In addition, several other similar colonies in the surrounding countryside were kept under regular observation as checks. All the wells were situated in the midst of bajra cultivation, a typical site and environment for baya nests in the Poona neighbourhood.

Through timely precautions it was possible to save the nests from destruction by local farmers, thus enabling our investigation to be continued more or less uninterruptedly throughout the nesting season.

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[1] For the earlier contribution on this subject see *JBNHS*, 53: 381-389 (1956).

The well which housed the Control Colony has been in seasonal occupation every year at least since 1951, and though we have no statistics for years previous to 1954, our impression is that the size of this colony has remained constant. During the last three seasons the position was as follows:

Season	♂♂	♀♀	*Completed occupied nests*	*Part-built nests*
1954	5	10	10	1
1955	4	6 (?)	10	1
1956	5	10	10	4

Since nothing is known regarding the composition of such colonies, whether the occupants in successive years are largely (if at all) the same birds or the offspring produced within the colony, special efforts were directed towards marking the occupants in a way that would enable them to be identified with certainty later on. By catching the males in drop traps, using seed bait and live decoys, we were able to colour-band *all* the males of the Control Colony, as well as all the females and young in the nests, and it is hoped that some interesting data may be forthcoming during the 1957 season.

To distinguish the birds of this colony during the current season, a small daub of green dye was put on their plumage in addition to various combinations of coloured rings. Red, the basic ring colour in these combinations, will distinguish Control Colony birds of the 1956 season in future. The dual marking enabled us to note the intra-colonial behaviour of the cocks as well as when members of adjacent colonies came together e.g. for collecting nest material in a jowar or bajra field.

Although nest building commenced in early June, the activities were tardy and spasmodic until immediately after the first really wet spell of the monsoon in August, when also the first heavy influx of hens was noticed. The visits of females gave a marked fillip to the building activities. Within a week or so of the break in the almost continuous downpour of the previous few days (9.28 inches between 25 July and 5 August)[1] the majority of the first 'flush' of nests was completed and occupied, while the presence of numerous additional unaccommodated females in the colony spurred the building cocks and kept up the tempo of their activity. The first egg in the Control Colony was laid on 19th August, the same date as in the previous year. That this is the principal egg-laying period in our Poona study area is suggested by the records of previous years, as follows:

Season			*First Egg*
1951	...	...	21 August
1952	...	...	6 August
1953	...	...	not recorded
1954	...	...	18 August
1955	...	...	19 August

At this stage of the monsoon there is normally a spell of several days of heavy and continuous rainfall during which nest-building comes to a standstill. Immediately a break supervenes intensified activities are resumed, and within less than a week many nests are completed and appropriated by females and first eggs laid. The eggs, as mentioned in our earlier report, are laid at 24-hour intervals, in the morning. (One definite record for the third egg of a clutch between 9 and 9.15 a.m.—26th August 1956.)

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[1] Annual norm for Poona 26 inches.

CLUTCH SIZE

Nests examined in the Poona area during the 1956 season gave the following:

No. of eggs in clutch	*No. of nests*	*Total eggs*
1	3	3
2	5	10
3	9	27
4	3	12
5	1	5
	21	57

Therefore average size of clutch 2.7.

The clutches of one egg may be incomplete, while five (which we also found twice in 1954) is exceptional and *may* possibly be the product of two females. The commonest clutch recorded this season as well as in 1954 was of three eggs.

Weight of Eggs: The average of 28 eggs was 2.24 gms., maximum 2.7 and minimum 1.9 gm. (both from different nests). VCA found that the second egg of a clutch is normally heavier than the first:

Average weight of first egg ...	... 2.168 gms.	(9 clutches)
Average weight of second egg...	... 2.235 gms.	,,

Also that eggs laid in the first flush of laying average heavier than those in later clutches (e.g. in September).

TABLE 1

WEIGHT OF FRESH-LAID EGGS

Date	*No. of Clutches examined*	*Average weight of first egg*	*Average weight of second egg*
19-25 August ...	7	2.24	2.27
5-24 September ...	2	2.0	2.2

These are interesting points on which further statistical data and confirmation are desirable.

INCUBATION

As recorded before, the female alone incubates, the male taking no part in this activity. During daytime the incubation is intermittent, the female flying in and out of the nest irregularly. Maximum period recorded in nest 13 minutes; minimum 1 minute.

Incubation is continuous during the night, the female entering the nest about sunset and emerging before sunrise. Incubation normally commences with the second egg, but in case of larger clutches sometimes not till the clutch is completed.

Incubation (previously reported by us as 14 to 15 days) lasts from 13 to 18 days but mostly 16, as seen from the following:

TABLE 2

Period to hatching (from 1st egg)		*No. of cases observed*
13 days	...	1
14 ,,	...	2
15 ,,	...	1
16 ,,	...	5
17 ,,	...	1
18 ,,	...	1

VCA directed special attention this season to the weights of nestlings. The young are born naked with a few scanty traces of down on head, back, and thighs. There were in all 11 nestlings in the 9 nests of Control Colony at the time, of which two died when 5 and 6 days old respectively. The weighing was done at dusk each evening, the individual chicks being identified by means of coloured dyes with which their down was daubed.

The following table gives the details:

TABLE 3

No. of Young	*Age in days*	*Weight Range in gms.*	*Average in gms.*
11	1	2.15– 3.4	2.54
11	2	3.1 – 4.7	3.7
11	3	4.0 – 5.6	5.0
11	4	4.4 – 7.8	6.9
10	5	5.5 –10.8	8.4
9	6	8.05–13.0	10.6
9	7	10.5 –15.2	12.9
9	8	12.2 –16.2	14.6
9	9	14.1 –19.5	16.9
9	10	17.7 –22.1	19.4
9	11	19.2 –24.3	21.6
9	12	17.6 –24.0	21.3
9	13	19.2 –24.5	22.1
9	14	21.5 –23.7	22.4
9	15	23.7 –24.3	24.0
8	16	20.1 –25.6	22.9

It will be seen from the above that the maximum weight was attained on the 15th day after hatching.

Table 4 sets out the weights of the two young in a selected nest (No. 17), and shows that the maximum was attained by the larger of the two on the 18th day. It then weighed 26.0 gms. which is more than the average weight of adults, 24 gms. (for ♂ and ♀). On the 19th day the weight of both chicks was found to be less than on the evening before. They both left the nest on the 20th day. In doing so, the larger chick accidentally fell into the water of the well and was instantly seized by a turtle and devoured. Accidental drowning and predation by turtles and bull frogs in this manner are minor secondary mortality factors in colonies situated in wells.

TABLE 4

Age in days	*Weight of young in gms.* *Red*	*Green*	*Increase in wt. of young in gms.* *Red*	*Green*
1	2	3	4	5
1	2·3	2·6		
2	3·9	3·1	1·6	0·5
3	4·0	?	0·1	—
4	?	4·4	—	—
5	5·5	6·1	—	1·7
6	8·0	8·6	2·5	2·5
7	10·5	10·5	2·5	1·9
8	12·5	12·2	2·0	1·7
9	15·1	14·1	2·6	1·9
10	15·8	17·7	0·7 (?)	3·6
11	19·2	19·3	3·4	1·6
12	20·1	20·8	0·9	1·5
13	21·6	21·4	1·5	0·6
14	22·2	?	0·6	?
15	?	24·3	—	—
16	24·9	24·5	—	0·2
17	24·2	25·1	—0·7	0·6
18	23·2	26·0	—1·0	0·9
19	23·1	24·2	—0·1	—1·8
20 Left	the nest.			

NESTLING PERIOD

Table 5 shows the period between hatching and leaving the nest. In 33% of the cases investigated, this period was found to be 17 days. Minimum 15/16 days, maximum 20 (13-14 days according to our previous report!):

TABLE 5

Days in nest	*Cases observed*
15	1
16	2
17	3
18	1
19	1
20	1
	9

NESTING SUCCESS

Eggs:

In the Control Colony there was a total of 10 completed and occupied nests. Of these one was inaccessible and its contents could not be examined. The aggregate of eggs laid in the remaining nine nests was 25, i.e. 2.7 per nest. Eight eggs (in three nests) got destroyed owing to rivalry among the cocks, one was eaten by a *Calotes* lizard, 2 proved infertile, and 3 were robbed by an urchin—total 14. The remaining 11 eggs, or 44%, hatched in due time.

Young:

Two young in one nest were starved to death (reason unknown) when five and six days old respectively.

Thus, of the 11 that hatched out, 9 chicks (81.8%) grew up to leave the nest, or 36% of the eggs laid. Average success 1 chick per nest!

ABNORMAL NESTS

Why abnormal and double or multi-storeyed nests are found year after year only in certain colonies and almost never in others is open to speculation. However, one of the causes certainly seems to be want of approved attachment sites, though it is not clear what precise factors determine suitability in this regard.

In a fairly congested colony, not far from our Control Colony, which had 20 completed and occupied nests, was one nest containing four eggs. Three of these hatched and in due course the full fledged young left the nest. Instead of building another nest in a fresh site, the cock sealed off the entrance tube of his first nest and used it as the point of suspension for his second nest. The latter was duly occupied by a hen (the same ?) who laid two eggs and successfully reared the chicks to adolescence.

In another case it was observed that due to violent buffeting by monsoon gales, the entrance tube had swung up and got caught in some thorny twigs above, rendering the passage unusable. To overcome this obstruction, the cock built an alternative entrance tube from below.

Weight of normal nests:

After drying out for several days, the weight of 11 completed nests averaged 56.8 gms.; maximum 70.4 gms., minimum 33 gms. VCA notes that a few of the nests hanging down the shafts of wells lacked the blobs of mud in the interior. We have as yet found no explanation for the apparently non-functional blobs of mud seen in the vast majority of nests.

SEX RATIO

P. philippinus is polygamous, each male having 2 or 3 females during the breeding season. Thus the tertiary sex ratio (i.e. of adult birds) is 1 ♂ : 2 (or 3) ♀♀. In order to determine whether this same sex ratio holds good from the nestling stage or is brought about later, 35 nestlings were dissected when almost ready to leave the nest. Of these, only in one case the sex remained uncertain.

Owing to the difficulty of accurate sexing at the time of hatching, dissection was not attempted till the birds were more or less fledged.

Strangely enough, as will be seen from Table 6, there was actually a preponderance of males over females, in the proportion 1.3 : 0.9 per nest; or 100 : 70.

If these figures and ratio are sustained by further investigation in the 1957 season, they will open up a number of intriguing problems.

TABLE 6

Season	*Nest No.*	*Total young*	♂	♀	o?	
1955						
24 Sept.	1	3	2	1	—	
26 ,,	2	2	1	1	—	
10 Oct.	3	1	1	—	—	+ 1 addled (?) egg
12 ,,	4	3	1	1	1	+ 1 addled (?) egg
14 ,,	5	3	2	1	—	
15 ,,	6	3	2	1	—	
1956						
26 Sept.	1	2	1	1		
29 ,,	2	1	1	—		
,, ,,	3	1	—	1		
1 Oct.	4	2	1	1		
3 ,,	5	2	—	2		
19 ,,	6	3	2	1		
21 ,,	7	3	2	1		
22 ,,	8	3	2	1		
23 ,,	9	3	2	1		
	15 nests	35	20	14	1	

INTELLIGENCE

Nest Repair:

On the fifth day of incubation at 9.32 a.m. an oblong slit was made in a nest (No. 17) then containing two eggs. At 9.34 a.m. the female alighted on the nest and examined the hole, looked here and there and entered within. She came out again at 9.35, but re-entered at 9.36 and spent nine minutes on the eggs. At 10.1 she inspected the hole again and tried to pull the fibres at the cut edge across the hole without success. At 10.10 a.m. the male, who had not been there up to that time, saw the hole. He went away, but came back at 10.36 and started directly to repair the nest, first unsuccessfully by means of the existing fibres, later with the help of fresh material. At 11.30, i.e. in just under an hour, he had repaired the mutilation completely.

The same nest was opened up every evening between 9th and 28th September in order to take the weights of the chicks. It was completely repaired by the bird each day. When the nestlings were 8-9 days old the male joined the female in feeding them, thereafter both parents using the hole freely for entrance and exit. After the tenth day the cock did not close up the hole any more, but instead he wove the fibres in such a way that a hood or projection was formed above the hole. It had the twofold advantage of permitting convenient entry and exit, while at the same time protecting the young from rain and exposure. This pattern of 'utility' repair was quite novel.

2. The Bombay Area

On 20 May 1956 most old nests in the palmyra colony were cut down in order to clear the site for fresh observations. One of these old completed nests contained four hard-set eggs of *Lonchura malabarica*. Another held one fresh munia egg along with much old droppings of the birds, suggesting that the nest had already served to bring up a family, or been in use as a dormitory. Three completed disused nests and four half built ones were left untouched as possible focus for the bayas.

Sharing the head of this palm, amongst the mass of leaves, was a colony of about 12 large bats (*Cynopterus* or *Rousettus* ?), several small pipistrelles (sp. ?), and 3 or 4 pairs of palm swifts (*Cypselus*).

Some showers of rain during the previous week had served to attract a few bayas to this traditional nest site. The beginnings of the community choruses were in evidence and even four fresh tassel-like attachments for nests had been laid, though the birds working on these were as yet in ♀ plumage. At this stage, activity at the nest colony was only noticed in the early mornings. After about 8.30 a.m. no bayas were to be seen on the nest-tree, except for sporadic fleeting visits by individual birds.

Activities were suspended during a spell of heavy rainfall of several days in the first week of July. They were resumed at feverish tempo immediately a break in the weather occurred. There was tremendous noise, excitement, and wing-flapping at each female's arrival, all the building males getting thoroughly worked up, and many launching out in pursuit of the hens round and round the tree and trying to 'bump' rivals.

Two nests at the 'bell' or 'helmet' stage were appropriated by two females who, in the midst of and despite the general commotion, persisted in returning to them time and again. They sat complacently on the cross-bar and laconically pulled at a strand here and another there in the interior of the nest. Two or three times the respective owners, who meanwhile clung on the outside and fluttered excitedly, entered the nest and copulated with the hens in response to a food-begging, shivering invitation.

In one case, while a male was thus 'waiting on' outside with a female sitting on the cross-bar within, a second interested female alighted momentarily on this nest. She was immediately set upon by the cock, who seized her by a toe so that for one fleeting moment she hung thus under the nest, fluttering to free herself, and then made good her escape.

Females arriving at the colony, if pursued by a party of males before they had an opportunity of alighting on a nest, usually sought refuge in a neighbouring tree, followed by the amorous band. No copulations were, however, observed away from the nest.

On 8 July, 8 to 10 nests, completed or nearly so, including some of those left over from last season, were found lying beneath the nest-palm, snipped off at the attachment close to the dome, soggy and ruined by the almost continuous downpour of the week. Two of the completed ones among these derelicts held 6 and 4 fairly fresh baya eggs respectively. Presumably, a sufficient number of completed nests not being available, more than one female had had recourse to laying in the same nest (the normal clutch in the Bombay area is also 2 or 3 eggs). The popularity with site-prospecting females of the few completed nests available may have provoked the jealousy of the unsuccessful or backward rivals who were, without doubt, responsible for the vandalism.

On 17 July, nine breeding-plumaged males of this colony were netted on the ground immediately underneath the nest-palm with the aid of grain bait and live decoys. No females were attracted, those present in the colony being apparently uninterested in grain at this stage. All the nine males were ringed on the right leg: White, Red, Pink, Green, Blue, Yellow, White/Blue, White/Red, White/Pink. More females were present in the colony on this date than were available nests, and much competition among them was noticeable. Many of the 25 completed nests already contained chicks being fed by females on green grasshoppers. One roving female clung to the rim of the entrance tube of an occupied nest, making repeated attempts to enter. She was resisted by the occupant female with vicious lunges from the egg-chamber. A second female joined the intruder in her attempts to enter. A scuffle ensued between the two intruders and one of them was driven off. Similar attempts to force entry into other nests in the face of vigorous resistance from the occupant were also observed, and competition among the prospecting females for eligible nests in the colony was particularly lively at this period.

During the last week of July and beginning of August there was almost incessant rain (35 inches in about 10 days) accompanied by violent squalls. The colony presented a deserted and woe-begone appearance and many completed nests had been blown down. The females, however, continued to feed the chicks in such of the sodden nests as remained. These periodical spells of intensely wet and squally weather, which are a regular feature of every monsoon season, constitute an important primary factor in the mortality rate of the baya, though the severity of their effects varies with the stage in the nesting process at which they occur.

By 7/8 August, fresh building activity had already re-started with great vigour. The majority of the nests were now in the early stages, from the initial attachment to the bell or helmet stage. The strong invasion of prospecting females spurred the tempo of the activities; thus one nest, started at 8 a.m., had the loop and one side of the dome completed by 3.30 p.m. with the blobs of mud stuck within. The colony now contained *c.* 35 working males including the marked ones B, W, W/P, and W/R. The last had been missed from the colony ever since the day he was ringed and used as a decoy before release, presumably being thoroughly scared by the experience!

On 10 August, brisk building activity was still in progress between 9 and 11.30 a.m., but it waxed to fever pitch after *c.* 1 p.m. After this hour, numerous females were constant visitors to the colony causing unprecedented commotion and noisy *chee*ing choruses and wing-flapping among the working cocks. In between, the cocks were making hurried sorties for green strips, sometimes being out and back with material within two minutes.

On 29 August when sunset was at 6.57 I.S.T. all the females who were in occupation of nests had retired within for the night by 6.45. All the prospecting females had left the colony by 6.50. By 6.55 only 3 (or 4) males remained. The last male left the colony a couple of minutes later, and complete silence reigned thereafter.

On 2 September, a day of feverish activity during a lull in another week-long downpour, it was observed that the influx of prospecting females was heaviest for about 1½ hours in the late (sunny) afternoon, from about 5 p.m. till sunset.

Day-to-day progress in the construction of the various nests belonging to the colour-ringed and identifiable males was easily followed by a technique of superimposing each day's sketch plan of the colony upon that made on the previous visit. The results provided not only a clear indication of the time taken to complete the various nests, but also indubitable proof that each male is normally the owner of at least two nests, occasionally of three, and rarely even of four.

On 10 August, a ringed cock of the last category was busy tearing down his sodden nest which had contained young prior to the last onslaught of bad weather. A gaping hole in the side of the nest, opposite the egg chamber, proclaimed that the young had probably come to grief at the hands of some predator.

ABNORMAL NESTS

In our previous notes (*JBNHS*, 53: 385) we stated in regard to Jesse's account of a seven-storeyed nest, whose last three chambers contained 3, 3, and 2 eggs respectively, that if it was intended to mean that the chambers were in contemporaneous occupation then it was open to serious doubt. As happens all too often with ornithological observations, almost the day after that was written we came across an instance which suggests that some modification of that verdict may be necessary! A completed nest of one of the marked cocks (W/P) was in occupation by an incubating female who was seen constantly entering and leaving by the normal route, i.e. the entrance tube. On 29 August, ♂ W/P was noticed adding a lower chamber to this nest. He had blocked up the entrance tube at the mouth and was using this as the point of suspension for the second chamber. It was noticed, however, that a lateral hole had been bored in the tube just above the new attachment, through which the female now continued to enter and leave the upper chamber. On 4 September the second (lower) chamber was completed, though as yet minus a tube. It was, to all appearances, already occupied by a second female, but this could not be definitely ascertained. Unfortunately observations were cut short at this stage as SA had to leave the station, and further history of this second nest remains unrecorded. But it is a point for confirmation whether two or more storeys of a multiple nest are sometimes occupied by females contemporaneously in this apartment-house style.

COPULATION

Prior to the 1956 season our observations had failed to provide a satisfactory answer to where, and under what circumstances, copulation took place. From certain vibratory movements of a completed nest into which a male baya had followed his female, SA had suggested that it possibly took place within the nest. In the 1956 season we obtained ample corroboration of this except in that, *normally* at any rate, copulation takes place as soon as a female has approved of and appropriated a nest at the early bell or helmet stage. When she arrives at such an eligible nest the hen takes up her position on the loop or cross-bar ('chin strap') and busies herself with tugging at a strip here and another there within the dome. She is closely attended by the amorous builder who clings on the outside, excitedly fluttering his wings, pressing his attentions and making repeated efforts to enter after her. If the female is unready and seriously wishes to repel his advances she promptly whips round and snaps at him, sometimes again and again. Otherwise she encourages, or invites, him by tilting up her posterior with her breast lowered into the egg chamber and by a slight shivering of the wings, uplifted at the armpits, as in food-begging. The act lasts about a second, the cock resuming his position on the outside of the nest immediately thereafter, and the female either flying off or continuing on her perch. In one case the initial copulation took place at 5.55 p.m. It was repeated at 6.5 and again at 6.45 with an abortive attempt in the interval, at 6.35. Soon after the last copulation, the female left the colony for the night, to be followed a few minutes later by the cock at the close of the day's work.

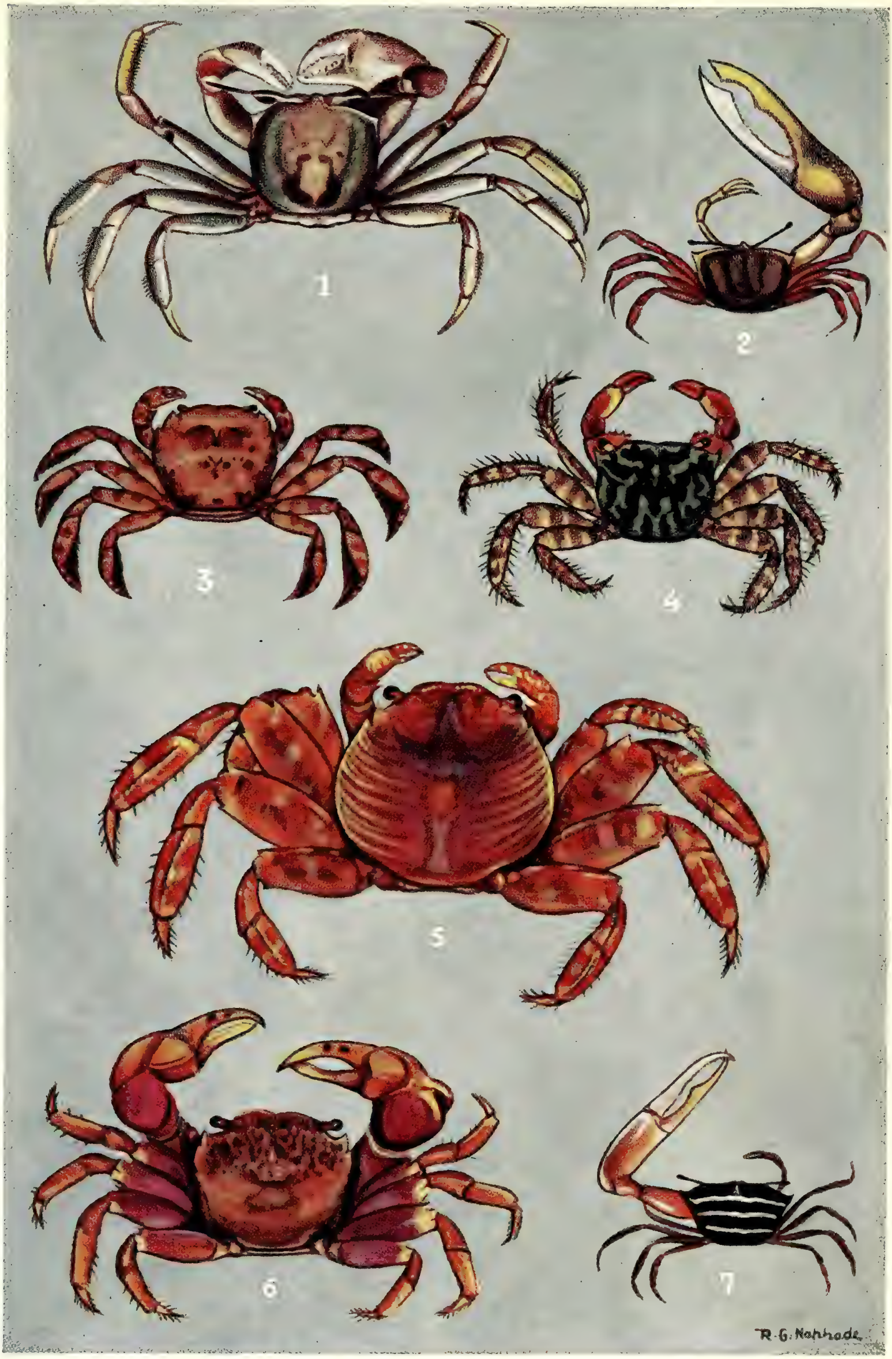
It was observed that cocks will surreptitiously attempt to copulate with the hens visiting an absent neighbour's nest, in the same way as they will filch his nesting material. As in the latter case, they flee precipitately upon the owner's return. In one instance the owner arrived while the act of 'adultery' was in progress. He broke off the pairing and spiritedly chased the intruder, who flitted across and settled on his own nest hard by while the owner himself took over the overtures to the hen. On the other hand a 'married' female, newly in possession of nest and mate, will sometimes snatch a hasty opportunity to hop across to a neighbouring eligible nest (i.e. in the appropriate helmet stage) in the momentary absence of its rightful 'mistress', deliberately exposing herself to the amorous impetuosity of the 'married' owner, and even inviting and permitting copulation.

Thus, while 'progressive polygamy' is now definitely established as the normal procedure in the baya, our observations in the 1956 season provide strong evidence also of fortuitous promiscuity in the sexual relations of both sexes.

SUMMARY

1. The numerical strength of a baya colony remains more or less constant from year to year. (p. 492.)
2. The significance of the blobs of mud found inside most nests, but not in all, remains un-understood. (p. 496.)

3. Nest-building activity reaches its highest tempo when a break in the weather supervenes after several days of continuous rain and squalls. The flush of egg-laying in a colony is more or less synchronous. (pp. 492 & 498.)
4. These recurring spells of bad weather during the nesting season are amongst the major primary *natural* mortality factors in baya colonies. Accidental drowning of chicks, and predation by turtles and bull frogs may be regular but minor secondary factors, especially in the well colonies. (Wholesale destruction by human agency, as reported in *JBNHS*, 53 : 389, is of local incidence.) (pp. 494 & 499.)
5. Average clutch size in the Poona area is determined. (p. 493.)
6. It is suggested that the average weight of the first egg laid is heavier than the second. Also that eggs in the earlier layings average heavier than late in the season. (p. 493.)
7. The incubation period is corrected to 16 days, mostly.
8. The nestling period is corrected to 16/17 days, mostly.
9. Daily weights and weight-ranges of nestlings in a controlled colony are given. (p. 494.)
   Also daily weights of two nestlings in a selected nest over the entire nestling period. (p. 495.)
10. Percentages of hatching and nestling success in a controlled colony are estimated. (p. 496.)
11. Sexing of nestlings when more or less ready to leave the nest showed an unexpected preponderance of males over females. (p. 496.)
12. Some more abnormal nests are described. (pp. 496 & 500.) Weights of some normal nests are given. (p. 496.)
13. An original pattern of utilitarian repair to an experimentally mutilated nest, suggesting a very flexible intelligence, is described. (p. 497.)
14. Activity and behaviour of nesting bayas in the Chembur colony are described, with special reference to ringed, identifiable males. (p. 499.)
15. A presumptive instance of two females occupying a 'tandem' or double-storeyed nest contemporaneously is cited. (p. 500.)
16. Details are presented of when and where copulation takes place. In addition to the baya being 'progressively polygamous' it is suggested that both males and females are fortuitously promiscuous in their sex relations. (p. 501.)



1. *Ocypoda ceratophthalma* × $\frac{2}{3}$.
2. *Gelasimus marionis nitidus* × $\frac{1}{2}$.
3. *Varuna litterata* × $\frac{2}{3}$.
4. *Metopograpsus messor* × 1.
5. *Grapsus strigosus* × 1.
6. *Sesarma (Sesarma) oceanica* × $\frac{3}{4}$.
7. *Gelasimus annulipes* × 1.

ON THE MARINE CRABS (DECAPODA : BRACHYURA) OF BOMBAY STATE*

BY

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PART II

(With one coloured and five line plates, and one text-figure)

(Continued from p. 439 *of this volume)*

Family *PINNOTHERIDAE*

Subfamily PINNOTHERINAE

Genus **Pinnotheres** Latreille

Pinnotheres placunae Hornell & Southwell

(Plate 12)

Pinnotheres placunae, Hornell & Southwell, *Rep. Marine Zool. Okhamandal,* p. 99 (1909).

Numerous specimens, of both sexes, were found living as commensals within the mantle-cavity of the bivalve *Placuna placenta* at Bombay. The majority were found near the anus. The dimensions of two specimens are given below, in terms of divisions—each division = 0.125 mm.

Male :

length of carapace ...	50 divs.	(or 6.25 mm.)
breadth of carapace ...	58 divs.	(or 7.25 mm.)
ratio of length : breadth of carapace ...	0.862	
Cheliped :—length of dactylus ...	13 divs.	
length of upper border of palm ...	20 divs.	
greatest width of palm ...	13 divs.	
ratio of length of dactylus : length of upper border of palm ...	0.65	
ratio of length of dactylus : width of palm	1.1	

Walking legs :—

	ischium & merus	carpus	propodus	dactylus	Total
Right : length of 1st leg	35	12	14	7	... 68 divs.
length of 2nd leg	40	13	20	9	... 82 divs.
length of 3rd leg	40	12	22	15	... 89 divs.
length of 4th leg	21	7	12	12	... 52 divs.

ratio of propodus : dactylus of 4th right leg ... 1:1

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* as it existed up to 31st October, 1956.

		ischium & merus	carpus	propodus	dactylus		Total
Left :	length of 1st leg	35	9	12	8	...	64 divs.
	length of 2nd leg	38	16	18	10	...	82 divs.
	length of 3rd leg	43	12	22	17	...	94 divs.
	length of 4th leg	19	9	10	12	...	50 divs.

ratio of propodus : dactylus of 4th left leg ... 0.833

Female :

length of carapace ... 60 divs. (or 7.5 mm.)
breadth of carapace ... 90 divs. (or 11.25 mm)
ratio of length : breadth of carapace ... 0.666
Cheliped :—length of dactylus ... 16 divs.
length of upper border of palm 25 divs.
greatest width of palm ... 14 divs.
ratio of length of dactylus : length of upper border of palm ... 2:3
ratio of length of dactylus : width of palm ... 1.14
Walking legs :—

		ischium & merus	carpus	propodus	dactylus		Total
Right :	length of 1st leg	33	9	12	10	...	64 divs.
	length of 2nd leg	36	17	18	11	...	82 divs.
	length of 3rd leg	40	16	21	14	...	91 divs.
	length of 4th leg	30	11	16	18	...	75 divs.

ratio of propodus : dactylus of 4th right leg ... 0.88

Left :	length of 1st leg	35	10	13	9	...	67 divs.
	length of 2nd leg	37	16	20	12	...	85 divs.
	length of 3rd leg	39	19	23	18	...	99 divs.
	length of 4th leg	30	11	14	16	...	71 divs.

ratio of propodus : dactylus of 4th left leg ... 0.87

In the female, the body is soft and membranous. The carapace is broader than long, circular, smooth and flat. The antero-lateral angles, though rounded, are pronounced. The external maxillipeds have the antero-internal angle of the ischium-merus rounded ; the dactylus does not extend to the apex of the propodus.

The legs increase in size posteriorly, except the last pair, which are smaller than the first. The dactyli of the last two pairs are 1½ times as long as those of the first two, those o f the last pair being more hairy at the tips. There is a thick tuft of hair at the distal end of the propodite of the last pair.

In the male, the carapace is smooth, and harder than in the female. The legs are slender. The first pair is about equal in length to the chelipeds, the second pair is longer than the first by slightly more than a dactylus, and the third is longer than the second by a dactylus. There is a thick tuft of hair at the distal end of the propodite of the last pair. The abdomen is narrow. Colour light pinkish.

This species is similar to *Pinnotheres similis* Burger, which too lives in *Placuna placenta*, but differs from it in the following :

(1) the front is not setose ;
(2) there are no spinules on the dactylus of the last leg ;
(3) the proportions of the lengths of the legs are different.

The anterior male abdominal appendages are long, cylindrical, and rod-like. Their tips are bent at the end in the shape of a claw, and bear coarse hairs near both margins.

According to Hornell and Southwell, the dactyli of the chelipeds are as long as their palm; in the specimens in the present collection, they are only three-fourths as long as their palm. Also, the anterior male abdominal appendages, according to these authors, always project from beneath the abdomen. In none of the present specimens can this be seen.

From 10 shells of *Placuna placenta* opened, four contained a male as well as a female crab; five contained a female, and one gave negative results. Almost all the females were berried.

This species has been previously recorded from Okha.

Pinnotheres vicajii Chhapgar

(Plate 12)

Pinnotheres vicajii, Chhapgar, *Rec. Ind. Mus.* liii (in press) (1955).

Female: Body soft, carapace subquadrate, anterior angles pronounced but with rounded corners, no pigment spots.

Merus-ischium of external maxillipeds is a broad plate with the inner (posterior) margin slightly concave and the antero-internal angle pronounced: propodus elongate, broad and spatulate, it reaches farther than the inner angle of the merus. Dactylus minute, styliform, inserted at inner margin of propodus, just over-reaching the inner angle of the merus, and reaching to the end of the propodus.

Third pair of walking legs the longest, last pair longer than the first; propodites with a few silky hairs distally; dactyli of the first two pairs subequal in length, strongly hooked, those of the third and fourth pairs about twice as long as the first two, subequal, hairy and slender, regularly curved.

Abdomen of seven joints.

Male: Carapace smooth, well calcified, circular, without any trace of anterior angles, covered with minute, scattered pigment spots on the anterior half of the carapace up to a line joining the bases of the second pair of walking legs.

Merus-ischium and propodus of external maxillipeds similar to those of the female, except that the propodus is abruptly narrowed in the distal half. The dactylus does not even reach the antero-internal angle of the merus, as it does in the female. There is a brush of hairs at the tip of the last joint of the exognath of the external maxillipeds, but no hairs along the sides of this joint.

Third pair of walking legs the longest, the last pair shortest: inner borders of carpus and propodus of the second and third pairs of legs, as also all borders of the last pair fringed with silky hairs. A fringe of hair runs diagonally from the inner border of the proximal end of the carpus to the outer border of the distal end of the propodus of the second and third pairs of legs. Dactyli of first three pairs of legs subequal, those of the last pair slightly shorter; all hairy.

Abdomen seven-jointed, narrow, no fringe of hair on its borders.

Colour yellow; in the male the carapace is covered with minute black pigment spots.

Four females (two of them berried), and two males represent the present collection. Both sexes were obtained from the bivalve *Paphia malabarica* at Bombay, each crab living separately in a shell.

The measurements of the type specimens in millimetres are given in the following table :

	Type female.	Type male.
Length of carapace ...	5·6	4·0
Breadth of carapace ...	6·4	4·0
Breadth of front ...	1·3	1·1
Breadth of anterior border of carapace	4·1	—

		left	right	left	right
1st walking leg					
	merus ...	0·75	0·75	0·84	0·84
	carpus ...	0·45	0·47	0·34	0·36
	propodus ...	0·66	0·67	0·47	0·49
	dactylus ...	0·28	0·28	0·20	0·23
2nd walking leg					
	merus ...	1·13	1.14	1·00	1·07
	carpus ...	0·50	0·56	0·45	0·45
	propodus ...	0·75	0·79	0·50	0·52
	dactylus ...	0·28	0·29	0·20	0·24
3rd walking leg					
	merus ...	1·69	1·13	1·70	1·73
	carpus ...	0·84	0·66	0·44	0·47
	propodus ...	1·28	0·90	0·60	0·75
	dactylus ...	0·46	0·38 (regenerated)	0·26	0·28
4th walking leg					
	merus ...	0·84	1·03	0·71	0·70
	carpus ..	0·41	0·52	0·37	0·33
	propodus ...	0·73	0·75	0·49	0·47
	dactylus ...	0·47	0·51	0·23	0·22

This species is allied to *Pinnotheres quadratus* Rathbun in the pigmentation of the male carapace and the small size of the dactylus of the external maxillipeds, but differs from it mainly in the circular male carapace, covered only in the anterior half with minute pigment spots, and without any trace of anterior angles, hirsute nature of the dactyli of all the legs, and narrow abdomen.

Family *OCYPODIDAE*

Subfamily OCYPODINAE

Genus **Ocypoda** Fabricius

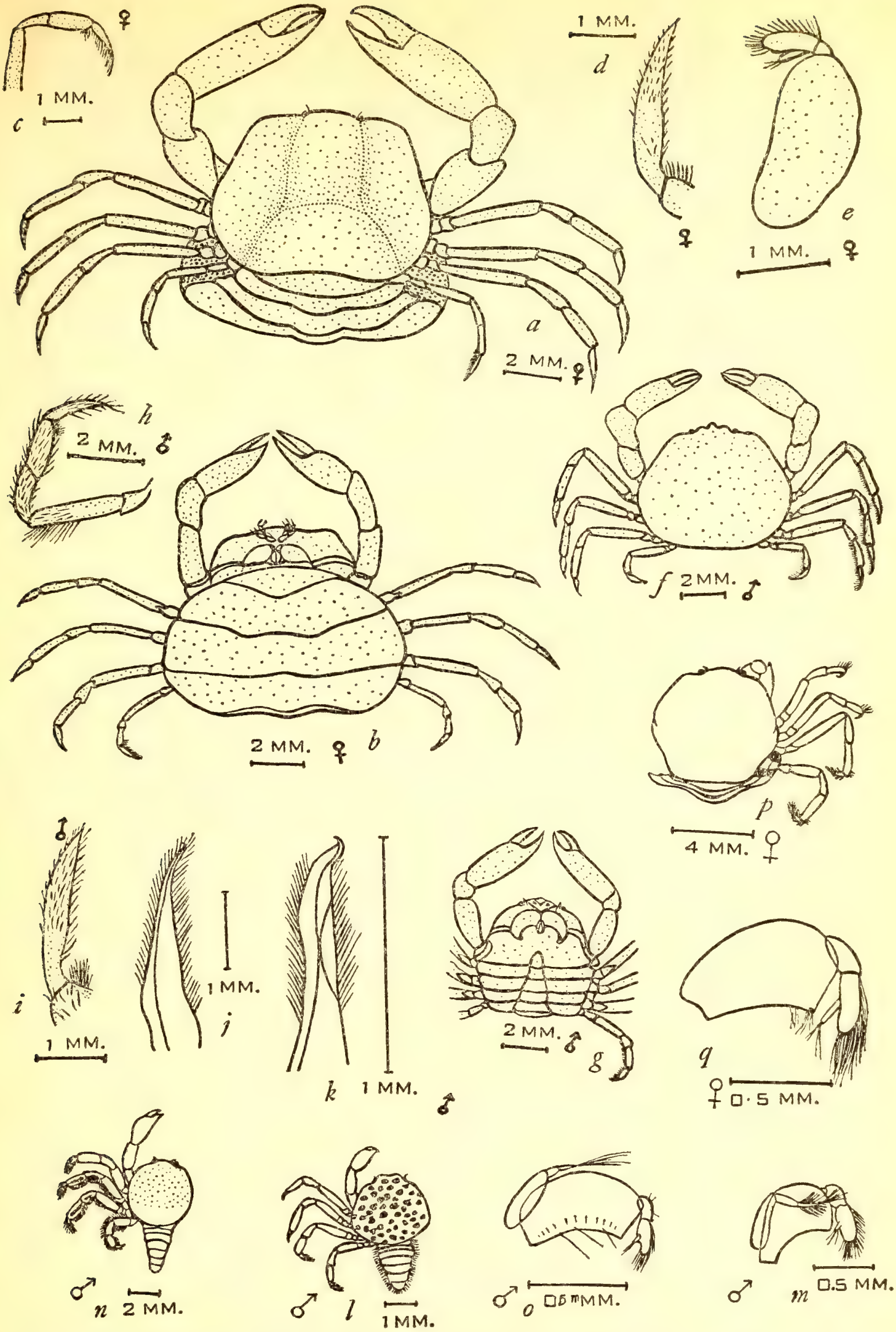
Ocypoda ceratophthalma (Pallas)

(Plate 13)

Ocypode ceratophthalmus, Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 86 (1950).

Ocypode ceratophthalma, Lanchester, *Proc. Zool. Soc. London*, p. 751 (1900).

Ocypoda ceratophthalma, Haswell, *Catalogue Austr. Crust.*, p. 94 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 107 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 387 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 345 (1900).


a
2 MM. ♀
b
2 MM. ♀
c
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♀
d
1 MM.
♀
e
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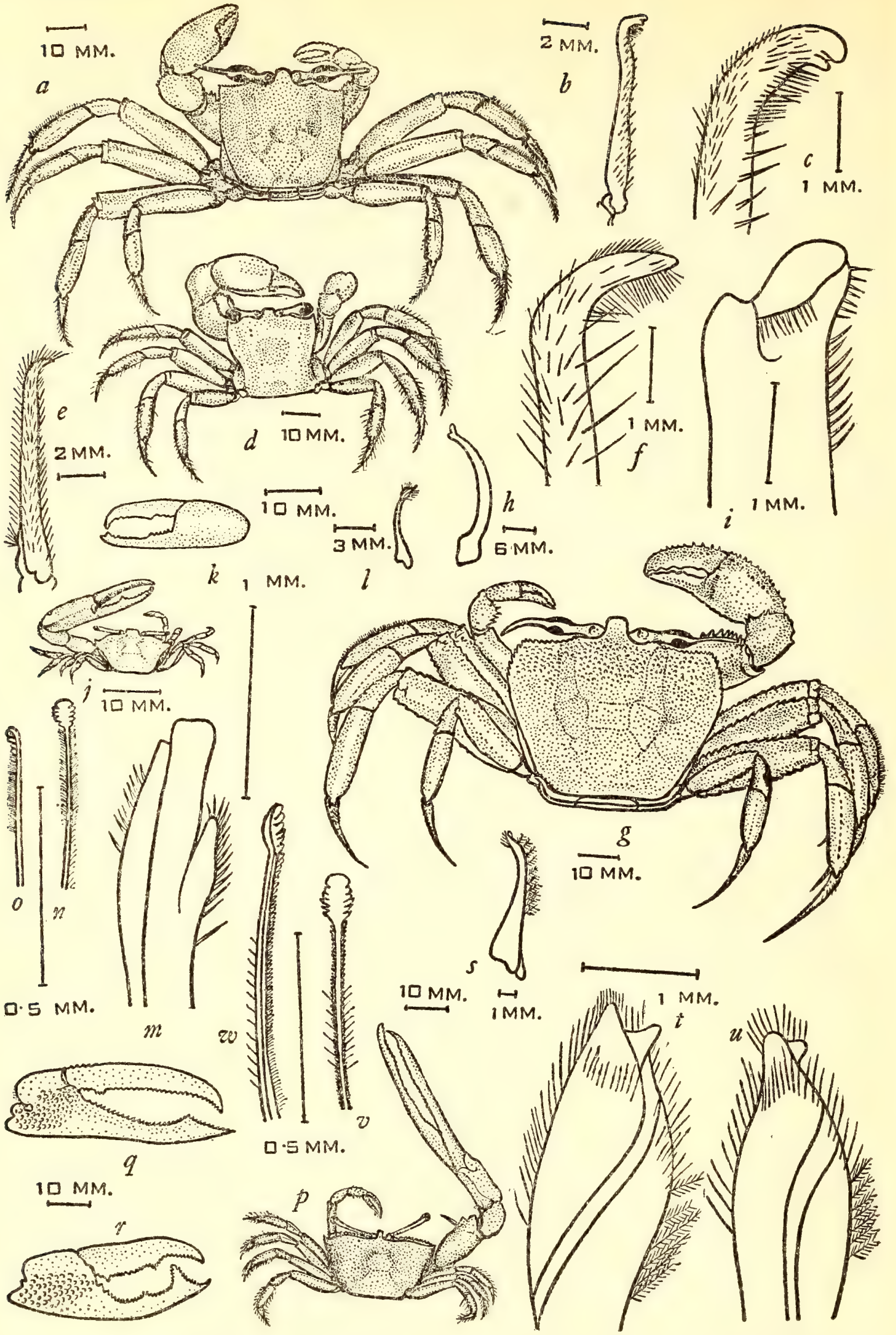
f
2 MM. ♂
g
2 MM. ♂
h
2 MM. ♂
i
1 MM.
♂
j
1 MM.
k
1 MM.
♂
l
1 MM.
♂
m
0.5 MM.
♂
n
2 MM.
♂
o
0.5 MM.
♂
p
4 MM. ♀
q
♀ 0·5 MM.

Pinnotheres placunae Hornell and Southwell : *a*. Female, dorsal view. *b*. Female, ventral view. *c*. 4th walking leg of female. *d*. Tip of same, enlarged. *e*. 3rd maxilliped of female. *f*. Male, dorsal view. *g*. Male, ventral view. *h*. 4th walking leg of male. *i*. Tip of same, enlarged. *j*. 1st left abdominal appendage of male. *k*. Tip of same, enlarged. *l*. Dorsal view of male *Pinnotheres quadratus* Rathbun. *m*. External maxilliped of same. *n*. Dorsal view of male *Pinnotheres vicajii* Chhapgar, with abdomen extended. *o*. External maxilliped of same. *p*. Dorsal view of female *Pinnotheres vicajii* Chhapgar. *q*. External maxilliped of same.


10 MM.
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p

Ocypoda ceratophthalma (Pallas) : *a*. Dorsal view of crab. *b*. 1st left abdominal appendage of male. *c*. Tip of same, enlarged. *Ocypoda cordimana* Desmarest : *d*. Dorsal view of crab. *e*. 1st left abdominal appendage of male. *f*. Tip of same, enlarged. *Ocypoda rotundata* Miers : *g*. Dorsal view of crab. *h*. 1st left abdominal appendage of male. *i*. Tip of same, enlarged. *Gelasimus annulipes* Latreille : *j*. Dorsal view of male. *k*. Cheliped of male. *l*. 1st left abdominal appendage of male. *m*. Tip of same, enlarged. *n*. Spooned hair on 2nd maxilliped, front view. *o*. Same, side view. *Gelasimus marionis* (Desmarest), and *Gelasimus marionis nitidus* Dana : *p*. Dorsal view of male *Gelasimus marionis*. *q*. Cheliped of same. *r*. Cheliped of male *Gelasimus marionis nitidus*. *s*. 1st left abdominal appendage of same. *t*. Tip of same, of *Gelasimus marionis* enlarged. *u*. Tip of same, of *Gelasimus marionis nitidus* enlarged. *v*. Spooned hair on 2nd maxilliped, front view. *w*. Same, side view.

Laurie, *Ceylon Pearl Oyster Fish. Report* (5) p. 426 (1906).
Parisi, *Atti. Soc. It. Sc. Nat.* lvii, p. 96 (1918).
Tesch *Siboga Exped. Rep.* xxxix, p. 36 (1918).
Gravely, *Bull. Madras Govt. Mus.* i, p. 148 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 418 (1937).
Tweedie, *Bull. Raffles Mus. Singapore* 13, p. 27 (1937).
Sakai, *Yokendo Ltd. Tokyo*, p. 614 (1939).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 153 (1950).
Tweedie, *Bull. Raffles Mus. Singapore* 21, p. 127 (1950).

Numerous specimens, of both sexes, were collected from Bombay, Karwar, Kolak, and Umarsadi. They live in burrows in sand. An average male measures:

length of carapace ...	29 mm.
breadth of carapace ...	33 mm.

This species is distinguished by the eyestalks prolonged to form a style, the presence of a stridulating organ consisting of tubercles passing into striae, and the anterior surface of the propodites of the first two pairs of legs being furnished with a brush of hairs.

Colour whitish, the inner border of the arm of the chelipeds cherry-red.

In the specimens in the present collection, the brush of hairs on the propodites of the second pair of legs is much sparser than that on the first.

The 'spooned' hairs found on the second maxillipeds in *Gelasimus* and *Macrophthalmus* are surprisingly absent in all *Ocypoda*, although the mode of feeding is similar.

The anterior male abdominal appendages are sharply bent near the tip, which is rounded and consists of two somewhat flattened and distally rounded lobes, separated by a narrow incision between them.

This species occurs from Tahiti to the east coast of Africa, and has also been recorded from the Bay of Bengal. This is the first record from the west coast of India.

Ocypoda cordimana Desmarest

(Plate 13)

Ocypode (*Ocypode*) *cordimana*, De Haan, *Fauna Japonica* v p. 57 (1850).
Ocypode cordimanus, Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 84 (1950).
Ocypode cordimana, Lanchester, *Proc. Zool. Soc. London*, p. 752 (1900).
Ocypoda cordimana, Haswell, *Catalogue Austr. Crust.*, p. 95 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 108 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 387 (1893)
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 349 (1900).
Parisi, *Atti. Soc. It. Sc. Nat.* lvii, p. 96 (1918).
Tesch, *Siboga Exped. Rep.* xxxix, p. 35 (1918).
Kohli, *Proc. Lahore Phil. Soc.* iii, p. 84 (1921-1922).

Gravely, *Bull. Madras Govt. Mus.* i, p. 148 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 420 (1937).
Tweedie, *Bull. Raffles Mus. Singapore* 13, p. 141 (1937).
Sakai, *Yokendo Ltd. Tokyo,* p. 613 (1939).
Shen, *Bull. Fan Mem. Inst. Biol. (Zool.)* x, p. 91 (1940).
Tweedie, *Bull. Raffles Mus. Singapore* 21, p. 126 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 27 (1951).

The present collection is represented by a male specimen from Umarsadi. It lives in burrows in sand. It measures :

length of carapace	... 23 mm.
breadth of carapace	... 24 mm.

This species is distinguished by the absence of a stridulating ridge and by the eyestalks not being prolonged to form a style.

Colour grey.

In the anterior male abdominal appendages there is no deep incision separating the two lobes at the tip, though the lobes are well differentiated.

This species has been previously recorded from the Bay of Bengal and Travancore. It occurs from Tahiti and Japan to the Red Sea. This is the first record from Bombay State.

Ocypoda rotundata Miers

(Plate 13)

Ocypoda rotundata, Alcock, *Journ. As. Soc. Bengal* lxix, p. 348 (1900).

A male from Okha is in the present collection. It lives in burrows in sand. It measures :

length of carapace	... 42 mm.
breadth of carapace	... 49 mm.

This species in distinguished by the antero-lateral angles being rounded off, and the length of the stridulating organ being much less than half the greatest breadth of the palm.

Colour white.

The anterior male abdominal appendages are curved throughout their length. The tip somewhat resembles a camel's head and bears a ridge with hairs. There are hairs also on the distal part of the outer border.

This species has been previously recorded from Cutch, Sind, and Baluchistan. This is the first record from Bombay State.

Genus **Gelasimus** Latreille

Gelasimus annulipes Latreille

(Plate 13)

Uca annulipes, Lanchester, *Proc. Zool. Soc. London,* p. 754 (1900).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 97 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 153 (1950).
Tweedie, *Sarawak Mus. Journ.* v, p. 356 (1950).
Gelasimus annulipes, de Man, *Journ. Linn. Soc. London (Zool.)* xxii, p. 118 (1887).
Henderson, *Trans. Linn. Soc. London (Zool.)* v, p. 388 (1893).

Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 353 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 425 (1906).
Kemp, *Mem. Ind. Mus.* v, p. 221 (1915–1924).
Gravely, *Bull. Madras Govt. Mus.* i, p. 148 (1927).
Tweedie, *Bull. Raffles Mus. Singapore* 13, p. 141 (1937).
Sakai, *Yokendo Ltd. Tokyo,* p. 616, (1939).
Pillai, *Bull. Central Inst. Travancore* ii, p. 28 (1951).

Numerous specimens, of both sexes, were collected at Bombay, Karwar, Okha, Kolak, and Umarsadi. They live in burrows in sandy mud. An average male measures:

length of carapace	... 10 mm.
breadth of carapace	... 18 mm.
breadth of front	... 3 mm.
length of larger hand	... 29 mm.

This species is distinguished by the subquadrilateral carapace with moderately convergent lateral borders, the front being a fifth to a sixth its breadth. The tip of the thumb of the chelipeds appears notched-truncate due to the presence of an enlarged tooth. An oblique granular ridge along the dentary edge of the thumb, and another along its lower edge, are present.

The anterior male abdominal appendages are bilobed at the tip, the larger lobe being blunt, the smaller one pointed ; both bear hairs.

There are peculiar 'spooned' hairs on the posterior half of the merus and the inner side of the tip of the palp of the second maxillipeds, used probably for feeding. The 'spoon' consists of about five rounded lobes on each side, continuing into hairs.

This species has been previously recorded from both the coasts of India. This is the first record from Bombay State.

Gelasimus marionis (Desmarest)

(Plate 13)

Uca marionis, Tesch, *Siboga Exped. Rep.* xxxix, p. 38 (1918).
Barnard, *Ann. S. Afr. Mus.* xxxviii. p. 90 (1950).
Gelasimus marionis, Alcock, *Journ. As. Soc. Bengal* lxix, p. 359 (1900).
Gravely, *Bull. Madras Govt. Mus.* i, p. 148 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 422 (1937).
Tweedie, *Bull. Raffles Mus. Singapore*-13, p. 143 (1937).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 90 (1940).
Pillai, *Bull. Central Inst. Travancore* ii, p. 29 (1951).

Numerous specimens were collected from Bombay. They live in burrows in sandy mud. An average specimen measures :

length of carapace	... 17 mm.
breadth of carapace	... 27 mm.
breadth of front	... 1.5 mm.
length of larger hand	... 45 mm.

In this species, the front is less than a fifteenth the breadth of the carapace. The upper surface of the wrist is granular, the fingers are compressed and blade-like, and the edge of the thumb has a simple S-shaped curve.

Colour in spirit blackish, claws white.

The smaller male cheliped is hairy. The larger hand is less than thrice the carapace length.

The anterior male abdominal appendages are suddenly sharp at the tip, which bears numerous long hairs. There is a lobe near the tip, from which a wide groove passes towards the base.

The spooned hairs on the second maxillipeds are present. The 'spoon' is wider than in *Gelasimus annulipes* and consists of about five lobes, the proximal three of which are pointed.

This species has been previously recorded from both the Bay of Bengal and the Arabian Sea. It ranges from Samoa and Fiji to the east coast of Africa and the Red Sea. This is the first record from Bombay State.

Gelasimus marionis nitidus Dana

(Plate 13)

Uca marionis var. *nitidus*, Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 154 (1950).
Tweedie, *Sarawak Mus. Journ.* v, p. 356 (1950).
Gelasimus marionis var. *nitidus*, Alcock, *Journ. As. Soc. Bengal* lxix, p. 360 (1900).
Gravely, *Bull. Madras Govt. Mus.* i, p. 148 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 422 (1937).
Tweedie, *Bull. Raffles Mus. Singapore* 13, p. 143 (1937).
Gelasimus marionis nitidus, Sakai, *Yokendo Ltd. Tokyo*, p. 622 (1939).
Shen, *Bull. Fan Mem. Inst. Biol* (*Zoot.*) x, p. 91 (1940).

This variety is distinguished from *Gelasimus marionis* by the cutting edge of the thumb being thrown into a W-shaped curve owing to the strong projection of two large triangular lobes.

Colour, locality, size, distribution, anterior male abdominal appendages and spooned hairs same as in *Gelasimus marionis*.

Opinions differ as to the validity of this variety. Tesch (1918) calls this variety as only a claw-variation of *Gelasimus marionis*. According to Tweedie it is probably a case of 'geographically local dimorphism confined to the males'. The females in the two forms are inseparable. This view is confirmed by the similarity of the anterior male abdominal appendages in the two forms.

Gelasimus dussumieri Milne-Edwards

(Plate 14)

Uca dussumieri, Lanchester, *Proc. Zool. Soc. London*, p. 753 (1900).
Tesch, *Siboga Exped. Rep.* xxxix, p. 39 (1918).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 153 (1950).
Tweedie, *Sarawak Mus. Journ.* v, p. 356 (1950).
Gelasimus dussumieri, Haswell, *Catalogue Austr. Crust.*, p. 93 (1882).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 361 (1900).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 91 (1940).

Numerous specimens of both sexes were collected from Kolak and Umarsadi. They live in burrows in mud. An average male measures :

length of carapace	... 21 mm.
breadth of carapace	... 34 mm.
breadth of front	... 2 mm.

In this species, the front is less than a fifteenth the greatest breadth of the carapace, which is at the acute, wing-like, antero-lateral angles. The fingers of the chelipeds end in simple hooked tips, and the meropodites of the last pair of legs are not foliaceous.

Colour in spirit chocolate-brown, chelipeds reddish yellow.

The anterior male abdominal appendages are split into two lobes at the tip.

The 'spoon' is long and narrow, consisting of about 13 large, well-separated, rounded lobes, followed by 13 smaller lobes. The five distal lobes are squarish, the others saw-like and anteriorly directed.

According to Rathbun, *Gelasimus acutus* of Stimpson is synonymous with this species. This species is very closely allied to *Gelasimus urvillei* Milne-Edwards, the latter being distinguished by the accessory row of granules on the lower orbital border. But de Man (1891) has recorded specimens showing traces of this accessory row, which in other respects (shape of carapace, etc.) resemble typical *dussumieri*. One of the specimens in the present collection also shows traces of this row of granules.

This species has been previously recorded from Mergui, the Andamans and Nicobars, and Bimlipatam. This is the first record from the west coast of India.

Subfamily SCOPIMERINAE

Genus **Dotilla** De Haan

Dotilla myctiroides (Milne-Edwards)

(Plate 14)

Scopimera myctiroides, Lanchester, *Proc. Zool. Soc. London*, p. 760 (1900).
Dotilla myctiroides, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 111 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 390 (1893).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 368 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 426 (1906).
Kemp, *Mem. Ind. Mus.* v, p. 227 (1915–1924).
Tesch, *Siboga Exped. Rep.* xxxix, p. 43 (1918).
Kemp, *Rec. Ind. Mus.* xvi, p. 326 (1919).
Gravely, *Bull. Madras Govt. Mus.* i, p. 149 (1927).
Tweedie, *Bull. Raffles Mus. Singapore* 13, p. 147 (1937).
Pillai, *Bull. Central Inst. Travancore* ii, p. 29 (1951).

Numerous specimens, of both sexes, from Bombay and Karwar represent the present collection. They live in muddy regions in colonies. An average specimen measures :—

length of carapace	... 9 mm.
breadth of carapace	... 8 mm.

This species is distinguished by the absence of any sculpture except the lateral grooves on the carapace, which is slightly longer than broad. The chelipeds are at least three times the length of the carapace. Tympana are present on all segments of the sternum.

Colour pinkish, chelipeds white.

There is no ' brain-convolution ' sculpture in this species.

The anterior male abdominal appendages are club-shaped at the tip, which bears tufts of hairs.

This species has been previously recorded from Mahe, Marmagao, Travancore, Rameswaram I., Tuticorin, Ennur, Chilka Lake, Tavoy and Mergui, the Andamans, Singapore, Java, Gaspar Straits and Billiton I., and Mindanao.

Subfamily MACROPHTHALMINAE

Genus **Macrophthalmus** Latreille

Macrophthalmus pectinipes Guerin

(Plate 14)

Macrophthalmus pectinipes, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 389 (1893).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 377 (1900).
Tesch, *Zool. Meded. Leiden* i, p. 156 (1915).
Kemp, *Rec. Ind. Mus.* xvi, p. 385 (1919).

Numerous specimens, of both sexes, were collected from Kolak and Umarsadi. An average male measures:

length of carapace	... 32 mm.
breadth of carapace	... 52 mm.

This species is distinguished by the carapace, the length of which is six-elevenths its breadth, being studded with large pearly granules. The eyestalks do not project beyond the antero-lateral angles. In the first three pairs of legs, the meropodites, carpopodites, and propodites are scabrous and serrated.

Colour a uniform grey, the tubercles pearly white.

This species is also known by the synonym *Macrophthalmus simplicipes* Guerin.

In the specimens in the present collection, there is a spine or two on the ischium of the legs on the ventral border.

The anterior male abdominal appendages bear two lobes at the tip—the inner one straight and slender, the outer bent outwards. Both bear hairs, each hair being striped with alternate brown and white bands.

There are three types of hairs on the second maxillipeds in all *Macrophthalmi*, viz. very long smooth hairs, shorter barbed hairs, and very short spooned hairs. The ' spoon ' is very long and narrow, and consists of irregular lobes. The last lobe is bent at right angles when seen in a side view.

This species has been previously recorded from Sind, Karachi, Bombay, Cuttack (or Cutch ?), and Penang.

Macrophthalmus sulcatus Milne-Edwards

(Plate 14)

Macrophthalmus sulcatus, Alcock, *Journ. As. Soc. Bengal* lxix, p. 379 (1900).
Tesch, *Zool. Meded. Leiden* i, p. 165 (1915).
Kemp, *Rec. Ind. Mus.* xvi, p. 388 (1919).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 101 (1950).

A mutilated male specimen from Umarsadi and another from Bombay represent the present collection. The specimen from Bombay measures:

length of carapace	... 7 mm.
breadth of carapace	... 17 mm.

In this species the true first antero-lateral tooth appears to belong to the upper border ot the orbit, so that the antero-lateral angle of the carapace is formed by the much larger second tooth, which also is the apparent outer orbital angle. The eyes reach not only beyond the orbits, but also beyond the antero-lateral angles.

The tip of the anterior male abdominal appendage is rounded and broadened like a drum-stick, and bears coarse hairs.

At the upper border of the inner angle of the wrist is a sharp spinule, and there is another exactly below it on the lower border.

The 'spoon' is short and broad, and consists of about five backwardly-directed saw-like lobes.

This species has been previously recorded from Cutch, Mauritius, and Australia. The last locality, according to Kemp (1919), seems to be erroneous.

Macrophthalmus latreillei Desmarest

(Plate 14)

Macrophthalmus latreillei, Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 427 (1906).
Tesch, *Zool. Meded. Leiden* i (1915).
Sakai, *Yokendo Ltd. Tokyo,* p. 626 (1939).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 154 (1950).

The present collection is represented by three males and two females from Bombay. An average male measures:

length of carapace	... 23 mm.
breadth of carapace	... 31 mm.

In this species, the shape of the carapace varies from nearly equilateral to transversely elongated. The whole surface is covered with large granules and, in the young, hairs. There are four teeth on the lateral borders, and the front is one-tenth the breadth of the carapace. The chelipeds of the male are remarkably small. The finger has a tooth near the base, and the thumb is curved downward in the adult, but in line with the palm in the young. A spine is present at the distal end of the meropodites of the last pair of legs.

Colour uniformly grey. The dactyli and the distal half of the propodites of the first three pairs of legs are tinged with a faint violet.

The anterior male abdominal appendages are straight and thick. The tip is narrowed to a sting-like point and bears long hairs.

The 'spoon' is very long and narrow, and consists of lobes of gradually decreasing size.

This species has been previously recorded from Madagascar, Malacca, Luzon, Philippines, Hong Kong, New Caledonia, Japan, Singapore, Gulf of Manaar, Siam, and Makassar. This is the first record from the west coast of India.

Macrophthalmus pacificus Dana

(Plate 15)

Macrophthalmus pacificus, Tesch, *Zool. Meded. Leiden* i, p. 190 (1915).
Kemp, *Rec. Ind. Mus.* xvi, p. 391 (1919).
Sakai, *Yokendo Ltd. Tokyo*, p. 628 (1939).

The present collection is represented by a male from Okha. It measures:

length of carapace	...	11 mm.
breadth of carapace at external orbital angles	...	13 mm.
greatest breadth of carapace	...	16 mm.
breadth of front	...	2 mm.

The carapace is smooth, and two-thirds as long as broad. The lateral borders are divergent posteriorly, and have three teeth. The eyes do not reach the orbital teeth. On each branchial region are two longitudinal, parallel, granular eminences, with a third near the postero-lateral angle.

Colour uniform grey.

The anterior male abdominal appendages are thick and slightly curved, densely covered with barbed hairs along the outer margin. The tip is blunt and angular, and bears a brush of smooth hairs.

There is almost no 'spooning' on the hairs of the second maxillipeds, which consist of numerous lobes.

This species has been previously recorded from Portuguese India, Nicobars, Penang, Loo Choo Is., Australia, and Samoa.

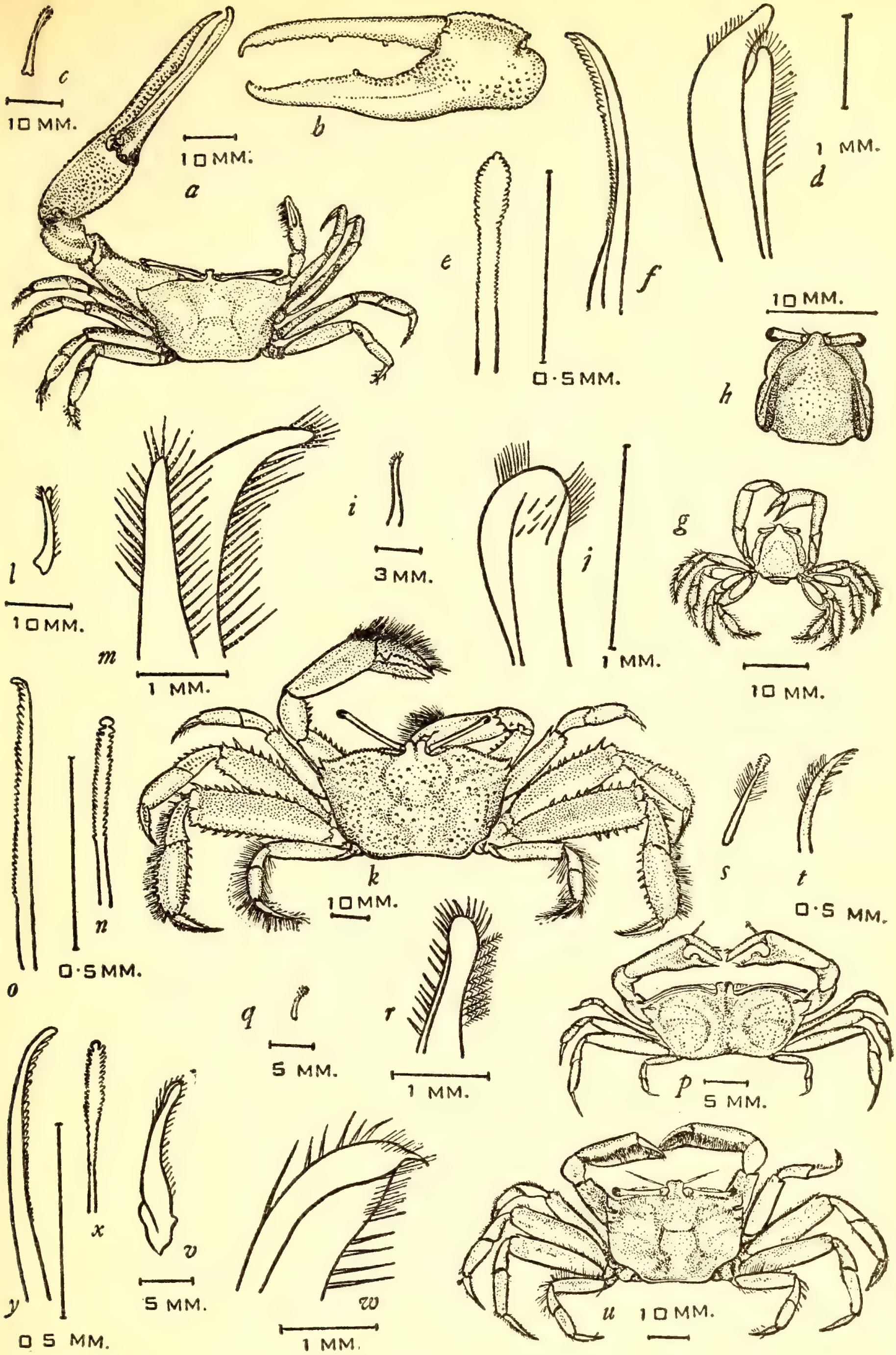
Macrophthalmus depressus Rüppell

(Plate 15)

Macrophthalmus depressus, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 124 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 389 (1893).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 380 (1900).
Tesch, *Zool. Meded. Leiden* i, p. 196 (1915).
Kemp, *Rec. Ind. Mus.* xvi, p. 392 (1919).
Gravely, *Bull. Madras Govt. Mus.* i, p 150 (1927).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 94 (1940).

The present collection is represented by a female from Bombay, and another from Kolak. The larger one measures:

length of carapace	...	12 mm.
breadth of carapace	...	20 mm.
breadth of front	...	3 mm.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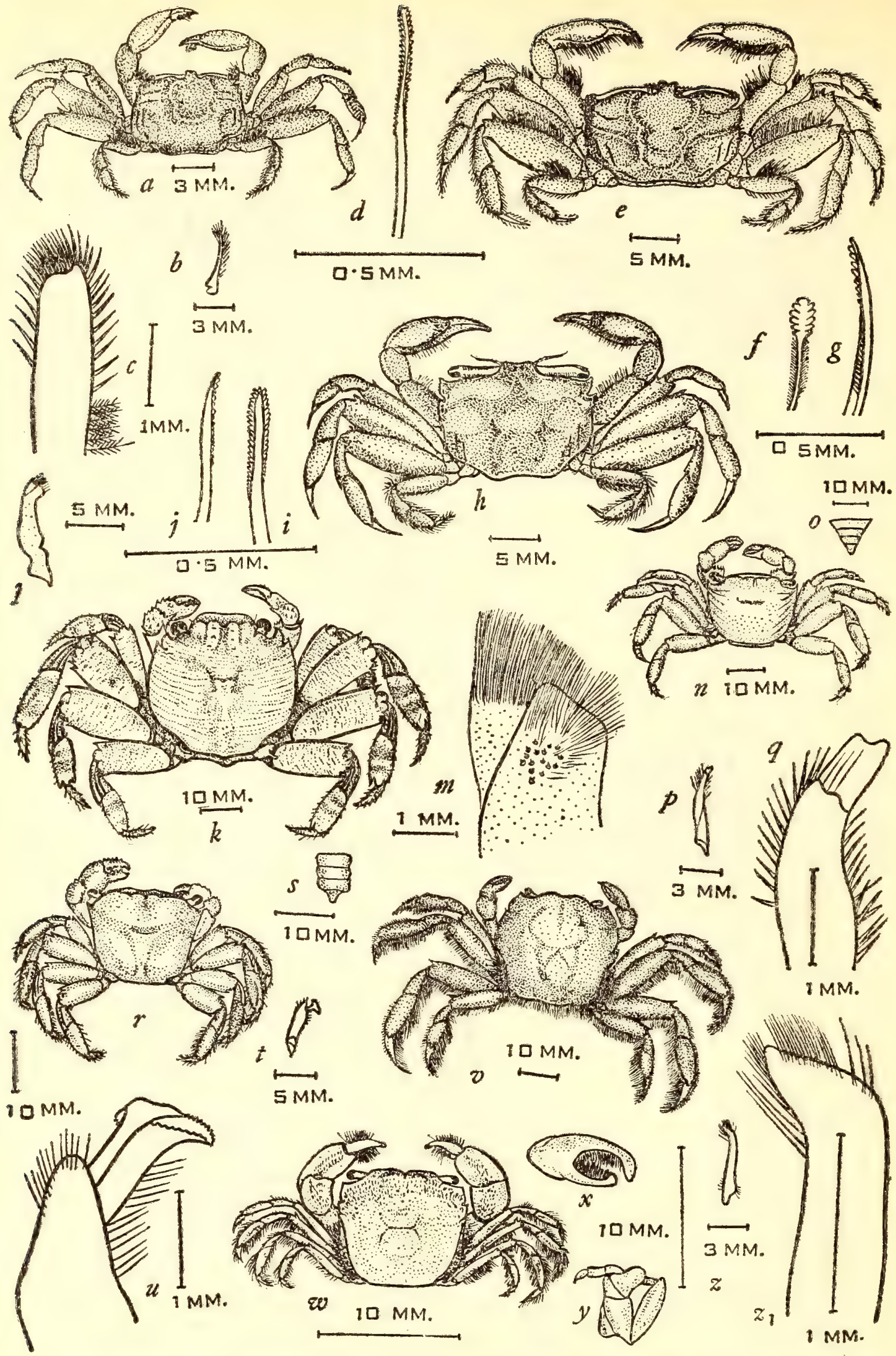
Gelasimus dussumieri Milne-Edwards: *a.* Dorsal view of male. *b.* Cheliped of male *c.* 1st left abdominal appendage of male. *d.* Tip of same, enlarged. *e.* Spooned hair on 2nd maxilliped, front view. *f.* Same, side view. *Dotilla myctiroides* (Milne-Edwards): *g.* Dorsal view of crab. *h.* Carapace, enlarged. *i.* 1st left abdominal appendage of male. *j.* Tip of same, enlarged. *Macrophthalmus pectinipes* Guerin: *k.* Dorsal view of male. *l.* 1st left abdominal appendage of male. *m.* Tip of same, enlarged. *n.* Spooned hair on 2nd maxilliped, front view. *o.* Same, side view. *Macrophthalmus sulcatus* Milne-Edwards: *p.* Dorsal view of male. *q.* 1st left abdominal appendage of male. *r.* Tip of same, enlarged. *s.* Spooned hair on 2nd maxilliped, front view. *t.* Same, side view. *Macrophthalmus latreillei* Desmarest: *u.* Dorsal view of male. *v.* 1st left abdominal appendage of male. *w.* Tip of same, enlarged. *x.* Spooned hair on 2nd maxilliped, front view. *y.* Same, side view.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Macrophthalmus pacificus Dana: *a.* Dorsal view of male. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d.* Spooned hair on 2nd maxilliped, front view. *Macrophthalmus depressus* Ruppell: *e.* Dorsal view of crab. *f.* Spooned hair on 2nd maxilliped, front view. *g.* Same, side view. *Macrophthalmus crinitus* Rathbun: *h.* Dorsal view of crab. *i.* Spooned hair on 2nd maxilliped, front view. *j.* Same, side view. *Grapsus strigosus* (Herbst): *k.* Dorsal view of crab. *l.* 1st left abdominal appendage of male. *m.* Tip of same, enlarged. *Metopograpsus messor* (Forskal): *n.* Dorsal view of crab. *o.* Male abdomen. *p.* 1st left abdominal appendage of male. *q.* Tip of same, enlarged. *Metopograpsus maculatus* Milne-Edwards: *r.* Dorsal view of crab. *s.* Male abdomen. *t.* 1st left abdominal appendage of male. *u.* Tip of same, enlarged. *Varuna litterata* (Fabricius): *v.* Dorsal view. *Pseudograpsus intermedius* Chhapgar: *w.* Dorsal view of male. *x.* External view of chela of male. *y.* External maxilliped. *z.* 1st left abdominal appendage of male. z_1. Tip of same, enlarged.

In this species, the carapace is studded with minute granules. The lateral borders are parallel, and the antero-lateral angle is a square-cut lobe. On the epibranchial region are two nearly parallel, obliquely longitudinal, finely granular lines.

Colour greyish.

The 'spoon' is short and broad, consisting of about six rounded lobes.

This species has been previously recorded from the Red Sea, Persian Gulf, Bombay, Pondicherry, and Rameswaram I.

Macrophthalmus crinitus Rathbun

(Plate 15)

Macrophthalmus crinitus, Tesch, *Zool. Meded. Leiden* i, p. 192 (1915).
Kemp, *Rec. Ind. Mus.* xvi, p. 390 (1919).
Macrophthalmus (?) *crinitus*, Tweedie, *Sarawak Mus. Journ.* v, p. 360 (1950).

Three females from Okha represent the present collection. An average specimen measures :

length of carapace	... 9 mm.
breadth of carapace	... 11 mm.
breadth of front	... 3 mm.

In this species the carapace is $\frac{3}{4}$ as long as broad, being widest behind the tip of the first antero-lateral tooth. The lateral borders are parallel. The orbital teeth are not very sharp, and their outer margins are parallel.

Colour greyish.

The hairs on the second maxillipeds are very thick, and almost without spooning.

This species is closely related to *Euplax bosci*. It has been previously recorded from Halmaheira, Amboina, Mergui, and Singapore. This is the first record from India.

Family GRAPSIDAE

Subfamily GRAPSINAE

Genus **Grapsus** Lamarck

Grapsus strigosus (Herbst)

(Plate 15)

Grapsus strigosus, Haswell, *Catalogue Austr. Crust.*, p. 97 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 148 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 390 (1893).
Alcock & Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 393 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 755 (1900).
Tesch, *Siboga Exped. Rep.* xxxix, p. 71 (1918).

Maccagno, *Ann. Mus. Stor. nat. Genova* lix, p. 178 (1935-1937).
Tweedie, *Bull. Raffles Mus. Singapore* 12, p. 45 (1936).
Chopra & Das, *Rec. Ind. Mus.* xxxix, p. 425 (1937).
Sakai, *Yokendo Ltd. Tokyo*, p 650 (1939).
Tweedie, *Bull. Raffles Mus. Singapore* 18, p. 28 (1947).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 115 (1950).
Tweedie, *Bull. Raffles Mus. Singapore* 21, p. 94 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 34 (1951).

Numerous specimens, of both sexes, were collected at Bombay and Okha. An average male measures :

length of carapace	...	31 mm.
breadth of carapace	...	34 mm.
length of upper border of palm	...	5.5 mm.
length of upper border of dactylus	...	9 mm.

This species is distinguished by the breadth of the front being 39-40 per cent of the distance between the external orbital angles, its free edge being not distinctly crenulate. The tooth at the inner angle of the orbit is subacute, and keeled. The tooth at the inner angle of the wrist of the chelipeds is nearly straight, not talon-like ; the length of the upper border of the palm is nearly two-thirds the length ot the dactylus. The first pair of legs is about as long as the last pair. The greatest breadth of the meropodites of the last pair is half its length. The distal part of the posterior margin of the last legs is dentate.

Colour dark reddish brown and white.

The propodites in all the legs have a terminal spine on the posterior border.

The anterior male abdominal appendages are very thick and have two lobes at the tip. The inner lobe bears a thick brush of dark brown hairs, while the outer bears lighter straw-coloured hairs and a patch of spinules.

This species is common in the Indian coastal waters, both in the Bay of Bengal and the Arabian Sea. Its range extends from the east coast of Africa to Polynesia and possibly to the west coast of America also.

Genus **Metopograpsus** Milne-Edwards

Metopograpsus messor (Forskal)

(Plate 15)

Metopograpsus messor, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 144 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 390 (1893).
Alcock & Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 397 (1900).
Calman, *Trans. Linn. Soc. London* (*Zool.*) vii, p. 24 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 429 (1906).
Tesch, *Siboga Exped. Rep.* xxxix, p. 79 (1918).
Gravely, *Bull. Madras Govt. Mus.* i, p. 147 (1927).
Maccagno, *Ann. Mus. Stor. nat. Genova* lix, p. 178 (1935-1937).

Sakai, *Yokendo Ltd. Tokyo*, p. 654 (1939).
Tweedie, *Bijdragen tot de Dierkunde* 28, p. 469 (1949)
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 118 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 156 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 35 (1951).

Numerous specimens, of both sexes, were collected at Bombay, Okha, and Umarsadi. It lives among rocks and is very active. An average male measures:

length of carapace	... 15 mm.
breadth of carapace	... 19 mm.
breadth of front	... 11 mm.

In this species the carapace is four-fifths as long as broad. There are some fine transverse markings on the post-frontal region. The front is about three-fifths the greatest breadth of the carapace; its free edge is sinuous and thin, but hardly laminar. The orbits are little oblique, the inner angle of their lower border being denticulate. The finger of the chelipeds is not much longer than the upper border of the palm. In the last three pairs of legs the greatest breadth of the merus is half its length. The terminal segment of the male abdomen is simply triangular.

Colour dark bottle-green; the claws in some adult males are a brilliant violet, in others bright orange, dull in the female; the legs are striped with alternate light and dark bands.

The male abdomen narrows gradually from the base to the terminal segment.

The anterior male abdominal appendages are in the form of a brown chitinous tube with its tip slightly bilobed and straw-coloured. Both the borders bear hairs at the distal end.

This species has been previously recorded from both the coasts of India, including Bombay. It ranges in distribution from the Red Sea to Australia.

Metopograpsus maculatus Milne-Edwards

(Plate 15)

Metopograpsus maculatus, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 145 (1887).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 398 (1900).
Tesch, *Siboga Exped. Rep.* xxxix, p. 80 (1918).
Pillai, *Bull. Central Inst. Travancore* ii, p. 35 (1951).

A few specimens, of both sexes, from Kolak and Umarsadi, are in the present collection. Habits and habitat same as *Metopograpsus messor*. An average male measures:

length of carapace	... 23 mm.
breadth of carapace	... 28 mm.
breadth of front	... 17 mm.

This species is distinguished by the carapace being seven-eighths as long as broad, with markedly convergent sides and the absence of transverse markings on the post-frontal region. The front is nearly three fourths the greatest breadth of the carapace; its free edge is nearly straight and laminar. The orbits are oblique, and the inner angle of their lower border is not dentate. The fingers of the chelipeds are much longer than the upper border of the palm. Except in the last pair of legs, the greatest breadth of the meropodites is decidedly less than half their length. The terminal male abdominal segment has a three-lobed appearance.

The segments of the male abdomen from the first to the penultimate are of the same width, their sides being parallel ; the last segment suddenly narrows to a point.

The anterior male abdominal appendages are coarse and thick ; the tip is a separate hammerhead-shaped lobe with serrated margins.

This species has been previously recorded from both the coasts of India, Ceylon, Mergui, and East Indies. This is the first record from Bombay State.

Subfamily VARUNINAE

Genus **Varuna** Milne-Edwards

Varuna litterata (Fabricius)

(Plate 15)

Trichopus litteratus, De Haan, *Fauna Japonica* v, p. 32 (1850).
Varuna litterata, Miers, *Catalogue New Zealand Crust.*, p . 40 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 103 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 391 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 401 (1900).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 24 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 756 (1900).
Kemp, *Mem. Ind. Mus.* v, p. 232 (1915).
Parisi, *Atti. Soc. It. Sc. Nat.* lvii, p. 105 (1918).
Tesch, *Siboga Exped. Rep.* xxxix, p. 85 (1918).
Gravely, *Bull. Madras Govt. Mus.* i, p. 147 (1927).
Hora, *Proc. Zool. Soc. London*, p. 881 (1933).
Tweedie, *Bull. Raffles Mus. Singapore* 12, p. 49 (1936).
Sakai, *Yokendo Ltd. Tokyo*, p. 665 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 99 (1940).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 122 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 156 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 36 (1951).

The present collection is represented by numerous females from Bombay and Kolak. The largest measures:

length of carpace	... 38 mm.
breadth of carpace	... 41 mm.

In this species the carapace is depressed and is very little broader than long. The legs have the three terminal joints compressed, dilated, and plumed. Colour mottled black and brown.

This species is commercially important in Bengal where it is eaten by the poor people, and where its numbers compensate for its small size (Hora, 1933).

It has been previously recorded from the east coast of Africa to New Zealand, Australia, and Japan. It is frequently found clinging to logs of driftwood in the open sea, which accounts for its wide distribution.

Genus **Pseudograpsus** Milne-Edwards

Pseudograpsus intermedius Chhapgar

(Plate 15)

Pseudograpsus intermedius, Chhapgar, *Rec. Ind. Mus.*, liii (in press) (1955).

Carapace squarish, flat, depressed, very little broader than long. Anterior half of carapace up to the cervical groove covered with minute, scattered, fine, brownish hairs, which are more profuse on the front, orbits, epigastric lobes, and lateral borders. Regions of carapace not well indicated except in the middle of the carapace where the grooves are disposed in the shape of the letter H. Cervical groove distinct but not very deep, semicircular. The antero-lateral borders are lined with profuse hair and cut into three distinct, flat teeth (including the external orbital angle) which decrease in size from before backward and are not serrate.

Buccal cavern square. External maxillipeds gaping, but not very widely : their exognath is narrower than the ischium : their merus shorter, but anteriorly much broader, than the ischium : it is auriculate (expanded) at the outer angle, so that the palp articulates near the middle of the merus.

The space between the fingers is covered with a thick matt of long entangled, silky hairs, under which, at the base of the fingers, is hidden a white fleshy lobe. The borders of the joints of all the legs, particularly the posterior border of the merus and both borders of the carpus and propodus, thickly fringed with long, dusky hairs. The anterior male abdominal appendages are stout and straight, but bent suddenly at the tip, which bears brushes of hairs.

Colour chestnut.

Ten males and four females (two of them berried) from Bombay city represent the present collection. They were caught in mud under stones.

The measurements of the type specimens are given below :

		male	female
length of carapace	...	10.0 mm.	6.75 mm.
breadth of carapace	...	11.0 mm.	7.25 mm.
breadth of front	...	4.0 mm.	2·60 mm.

Tesch[1], in the discussion of the *Grapsidae*, divides the species of *Pseudograpsus* into two different groups, viz.

(1) large species (up to 4 cm.), chestnut coloured. Cervical groove very deep, semicircular. Three last joints of the legs with a fur of black hairs ;

(2) small species (up to 1.5 cm.), white. Cervical groove indistinct, nearly straight. Legs naked.

It will be seen that this species offers a combination of the characters of the above two groups. Although it is a small species (measuring only up to 1 cm.), the specimens are chestnut coloured. Again, the cervical groove, though semicircular, is not very deep. The legs, too, are covered with dusky hair.

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[1] Tesch, J. J., *Siboga Exped. Rep.* xxxixc, pp. 97, 98 (1918).

Subfamily SESARMINAE

Genus **Sesarma** Say

Subgenus **Sesarma**

Sesarma (Sesarma) quadrata (Fabricius)

(Plate 16)

Grapsus (*Pachysoma*) *quadratus*, De Haan, *Fauna Japonica* v, p. 62 (1850).
Sesarma (*Parasesarma*) *plicata*, Tesch, *Zool. Meded. Leiden* iii, p. 187 (1917).
Sesarma (*Sesarma*) *quadratum*, Pillai, *Bull. Central Inst. Travancore* ii, p. 36 (1951).
Sesarma quadratum, Alcock, *Journ. As. Soc. Bengal* lxix, p. 413 (1900).
Gravely, *Bull. Madras Govt. Mus.* i, p. 147 (1927).
Sesarma quadrata, de Man, *Notes Leyden Mus.* xii, p. 99 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 392 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Lanchester, *Proc. Zool. Soc. London*, p. 756 (1900).
Sesarma (*Sesarma*) *quadrata*, Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 96 (1940).

Numerous specimens, of both sexes, were collected at Karwar, Kolak, and Umarsadi. It is a rock-dweller. An average male measures :—

length of carapace	... 17·5 mm.
breadth of carapace	... 20 mm.

This species is distinguished by the deep carapace which is broader than long, and without any tooth on the lateral borders behind the orbital angle. The front is more than half the greatest breadth of the carapace. The inner border of the arm bears a large tooth at its distal end. On the upper surface of the palm are two oblique pectinated ridges, and the dorsal surface of the male finger is milled with 11 to 19 blunt, transverse lamellae.

Colour mottled grey, the fingers cherry-red.

The anterior male abdominal appendages are bent outwards at the extreme tip, which bears hairs along both borders.

This species has been previously recorded from the coasts of India, Ceylon, the Andamans and Nicobars. This is the first record from Bombay State.

Sesarma (Sesarma) oceanica de Man

(Plate 16)

Sesarma oceanicum, Alcock, *Journ. As. Soc. Bengal* lxix, p. 423 (1900).
Sesarma (*Sesarma*) *rotundata*, Tesch, *Zool. Meded. Leiden* iii, p. 193 (1917).

Numerous specimens, of both sexes, from Kolak are in the present collection. An average male measures :

length of carapace	... 36 mm.
breadth of carapace	... 31 mm.
breadth of front	... 17 mm.
length of merus of leg	... 26 mm.
breadth of merus of leg	... 11 mm.

This species is distinguished by the shallow, depressed carapace, which is longer than broad, and has two teeth on the lateral borders behind the outer orbital angle. The post-frontal lobes of the gastric region are smooth. The fingers of the chelipeds have no milling. The meri of the legs are more than three times as long as broad, and the dactyli are short.

Colour of the carapace and legs varying from light violet to almost black. The palm and fingers of the chelipeds orange to cherry-red, finger tips white, extreme tips horny.

The carapace in its anterior half is covered with little dense tufts of hair resembling tubercles, amid a finer fur resembling granules.

The palm of the chelipeds is almost smooth, except for two granular ridges, one extending along the lower border up to the base of the immobile finger, the other along the inner edge of the same finger. The angular lobe near the far end of the inner border of the arm is hardly prominent, being a blunt projection. The inner angle of the wrist is pronounced but not dentiform ; close to and parallel to it runs a ridge ; a smooth ridge runs outside the granular ridge at the upper border of the palm. On the upper border of the dactylus are two horny teeth ; the tips of the fingers are cut off diagonally, resembling tongs. The meropodites of the legs are only 2½ times as long as broad. The male abdomen is long and narrow.

The anterior male abdominal appendages are straight up to the tip, which bears numerous long hairs.

This species has been previously recorded from the Nicobars. This is the first record from the west coast of India.

Sesarma (Sesarma) taeniolata White

(Plate 16)

Sesarma taeniolatum, Alcock, *Journ. As. Soc. Bengal* lxix, p. 419 (1900).
Sesarma taeniolata, Lanchester, *Proc. Zool. Soc. London*, p. 756 (1900).
Sesarma (*Sesarma*) *taeniolatum*, Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 96 (1940).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 157 (1950).
Sesarma (*Sesarma*) *taeniolata*, Tesch, *Zool. Meded. Leiden*, iii, p. 201 (1917).
Tweedie, *Bull. Raffles Mus. Singapore* 12, p. 53 (1936).

The present collection is represented by a mutilated male from Ratnagiri. It measures :

length of carapace	... 24 mm.
breadth of carapace	... 25 mm.

This species is distinguished by the deep, square carapace, covered with tufts of hair, and with a tooth on the lateral borders behind the orbital angle. There is a finely pectinated ridge on the upper surface of the palm, and another transverse granular ridge on its inner surface. The upper border of the finger in the male has a milled crest of 40-60 fine lamellae. The dactyli of the legs are two-thirds, or more, the length of the propodites.

Colour brown.

The anterior male abdominal appendages are slightly curved, with a bulge covered with hair near the tip.

This species has been previously recorded from Mergui, the Andamans, Malaya, Singapore, Thailand, and China. This is the first record from the west coast of India.

Sesarma (Sesarma) minuta de Man

(Plate 16)

Sesarma (*Sesarma*) *minuta*, Tesch, *Zool. Meded. Leiden* iii, p. 127 (1917).

A berried female was obtained from Bombay, clinging to the bivalve *Paphia malabarica*. It measures :

length of carapace	... 2·5 mm.
breadth of carapace	... 3·2 mm.

This species can be distinguished by its minute size, the carapace being broader than long. The upper border of the palm of the chelipeds has no longitudinal pectinated crest. The posterior borders of the meropodites of the legs are serrated near the carpus.

Colour lemon yellowish.

This species has been previously recorded from Batavia. This is the first record from India.

Genus **Metaplax** Milne-Edwards

Metaplax indica Milne-Edwards

(Plate 16)

Metaplax indica, Alcock, *Journ. As. Soc. Bengal* lxix, p. 432 (1900).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 95 (1940).

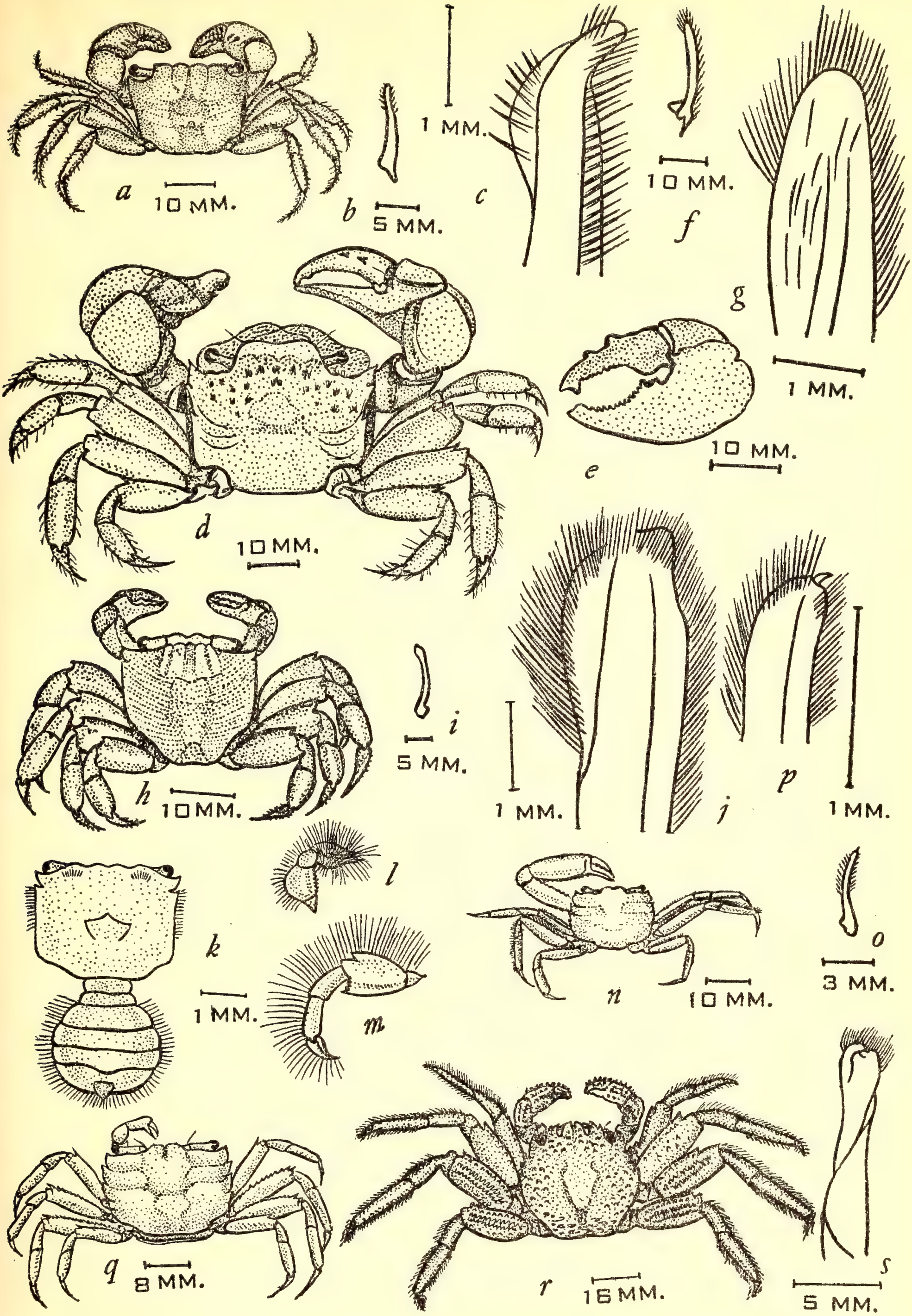
The present collection is represented by a male from Kolak. It measures :—

length of carapace	... 12 mm.
breadth of carapace	... 18 mm.

This species is distinguished by the equal sized male chelipeds, which are less than three times the length of the carapace. The finger has no prominent lobe on its dentary edge. The anterior borders of the carpopodites and propodites of the legs are smooth. The third, fourth, and fifth male abdominal segments are fused. There are seven to nine teeth on the male infra-orbital ridge beginning with four or five small teeth, followed by two larger rounded lobules, that are separated by a large inter-space from three very small tubercles in the lateral part of the ridge.

Colour grey, legs and chelipeds pink, the fingers a darker pink.

In the specimen in the present collection, the inner border of the arm, lower border of the hand, and teeth of the antero-lateral borders are serrated. The front is bilobed. The meropodites of all the legs, and the propodites and carpopodites of the middle two are densely hairy only on the anterior border. The third, fourth, and fifth male abdominal segments are only partly fused.


a
10 MM.
b
5 MM.
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5 MM.

Sesarma (*Sesarma*) *quadrata* (Fabricius): *a*. Dorsal view of crab. *b*. 1st left abdominal appendage of male. *c*. Tip of same, enlarged. *Sesarma* (*Sesarma*) *oceanica* de Man: *d*. Dorsal view of crab. *e*. Cheliped, external view. *f*. 1st left abdominal appendage of male. *g*. Tip of same, enlarged. *Sesarma* (*Sesarma*) *taeniolata* White: *h*. Dorsal view of crab. *i*. 1st left abdominal appendage of male. *j*. Tip of same, enlarged. *Sesarma* (*Sesarma*) *minuta* de Man: *k*. Dorsal view of female, with abdomen extended. *l*. Cheliped of female. *m*. 3rd walking leg. *Metaplax indica* (Milne-Edwards): *n*. Dorsal view of male. *o*. 1st left abdominal appendage of male. *p*. Tip of same, enlarged. *Metaplax distincta* Milne-Edwards: *q*. Dorsal view of female. *Plagusia depressa tuberculata* (Lamarck): *r*. Dorsal view of crab. *s*. 1st left abdominal appendage of male.

In the anterior male abdominal appendages, there is a minute tooth at the extreme end of the broad tip. There are hairs along both the borders.

This species has been previously recorded from Karachi. This is the first record from Bombay State.

Metaplax distincta Milne-Edwards

(Plate 16)

Metaplax distinctus, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 158 (1887).
Metaplax distincta, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 391 (1893).
Alcock, *Journ. As. Soc. Bengal* lxix, p. 432 (1900).

The present collection is represented by a female from Karwar. It measures :

length of carapace	... 18 mm.
breadth of carapace	... 24 mm.

In this species the carapace is slightly less than three-fourths as long as broad. The lower border of the orbit in the male is prolonged to the level of the second notch in the lateral border. The lobules of the infra-orbital ridge are from 25 to 30 ; the lobules of the orbital portion (10-12) are small, and gradually decrease in size from within outward. The anterior border of the meropodites of the legs is armed, in the first and last pairs with a subterminal spine, in the middle two with several spines. The male abdomen consists of seven separate segments.

Colour a uniform grey.

In the specimen in the present collection, a small vestige of a fifth tooth is indicated, on careful examination, by a nick in the lateral borders. The posterior borders of the legs are microscopically beaded. The front is bow-shaped and obliquely deflexed. There is no tomentum on the legs. The carapace, on the front half and the sides, is granular.

This species has been previously recorded from Madras, Coconada, Mergui, and the Nicobars. This is the first record from the west coast of India.

Subfamily PLAGUSIINAE

Genus **Plagusia** Latreille

Plagusia depressa tuberculata (Lamarck)

(Plate 16)

Plagusia squamosa, Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 202 (1894).
Plagusia depressa var. *squamosa,* Alcock, *Journ. As. Soc. Bengal* lxix, p. 438 (1900).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (5) i, p. 432 (1903).
Pillai, *Bull. Central Inst. Travancore* ii, p. 38 (1951).
Plagusia depressa var. *tuberculata,* Kemp, *Mem. Ind. Mus.* v, p. 241 (1915-1924).
Montgomery, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 457 (1931).

Rathbun, *U. S. Nat. Mus. Bull.* 97, p. 334 (1917).
Tesch, *Siboga Exped. Rep.* xxxix, p. 129 (1918).
Tweedie, *Bull. Raffles Mus. Singapore,* 12, p. 69 (1936).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 158 (1950).

The present collection is represented by a male from Kodinar. It measures :

length of carapace	... 52 mm.
breadth of carapace	... 55 mm.

This crab is distinguished by the absence of a true front, so that the antennular fossae are visible in a dorsal view as deep clefts in the anterior border of the carapace. The regions of the carapace are distinct, and covered with flat pearly or squamiform tubercles. The antero-lateral borders are cut into four teeth. The chelipeds are massive, and have tubercles on the upper surface of the palm and finger arranged in longitudinal rows.

Colour reddish brown.

The specimen in the present collection is sparsely covered with weeds.

The anterior male abdominal appendages are stout, with a blunt tip covered with a thick brush of hairs.

The use of Herbst's name *squamosa* by Alcock, Stebbing, and others has been criticized by Laurie.

Distribution: Indo-Pacific, extending to the west coast of America.

KEY TO THE IDENTIFICATION OF THE MARINE CRABS OF BOMBAY STATE

1.	Mouth frame (buccal cavity) triangular (Oxystomata)	2.	
	Mouth frame (buccal cavity) more or less quadrate	10.	
2.	Carapace short, leaving the first two or three abdominal segments exposed. Last two pairs of legs dorsal in position, ending in hook-like dactyli (Dorippidae)	*Dorippe astuta*	p. 409
	Abdomen not visible dorsally. Legs normal in position	3.	
3.	Inhalant branchial openings in front of chelipeds. Gills nine. Male genital openings coxal (Calappidae)	4.	
	Inhalant branchial openings at bases of third maxillipeds. Gills less than nine. Male genital openings sternal (Leucosiidae)	6.	
4.	External maxillipeds not closing the buccal cavity completely, palp not concealed. Legs not adapted for swimming (Calappinae) ...	*Calappa lophos*	p. 404
	External maxillipeds completely covering the buccal cavity, palp concealed. Legs natatory, distal joints flattened and expanded (Matutinae).	5.	
5.	A distinct spine at the angle of the hand where it comes in contact with the external angle of the arm. Carapace covered with minute red dots ...	*Matuta lunaris*	p. 405
	Only a tubercle at the angle of the hand where it touches the external angle of the arm. Carapace covered with red spots, rings and vermicular lines	*Matuta planipes*	p. 406

6.	Carapace convex and subglobular, its surface smooth and polished	7.
	Carapace rhomboidal, its margins with large spines and tubercles	*Arcania septemspinosa* p. 408
7.	Front narrow. Exopodites of external maxillipeds narrow, with the outer margins straight (*Leucosia*)	8.
	Front broad. Exopodites of external maxillipeds broad, their outer borders forming a semicircle (*Philyra*)	9.
8.	Carapace longer than broad	*Leucosia pubescens* p. 406
	Carapace broader than long	*Leucosia sima* p. 407
9.	Carapace smooth, its regions hardly defined ...	*Philyra globosa* p. 407
	Regions of carapace forming independent swellings, covered with large granules ...	*Philyra corallicola* p. 408
10.	Last pair of legs modified, situated dorsally. Female genital openings coxal. First pleopod present in female. Gills usually numerous (Dromiacea)	11.
	Last pair of legs normal, rarely reduced, and only exceptionally dorsal in position. Female genital openings sternal. First pleopod absent in female. Gills few (Brachygnatha) ...	12.
11.	Last pair of legs shorter than the first two pairs.	*Dromia dormia* p. 401
	Last pair of legs longer than the first two pairs...	*Pseudodromia integrifrons* p. 402
12.	Carapace triangular, narrowed in front, usually with a distinct rostrum. Orbits generally incomplete (Oxyrhyncha)	13.
	Carapace broad in front, rostrum reduced or wanting. Orbits well developed (Brachyrhyncha).	19.
13.	Carapace flat, weakly calcified. Male genital openings on last thoracic sternite (Hymenosomidae)	*Elamena cristatipes* p. 409
	Carapace not flat, strongly calcified. Male genital openings on fifth coxopodites ...	14.
14.	Basal antennal joint well developed, generally fused with epistome and sometimes also with the sides of the rostrum. Chelipeds usually not vastly larger than legs (Maiidae)	15.
	Basal antennal joint very small, not fused with epistome or front. Chelipeds usually much longer and more massive than legs (Parthenopidae) ...	18.
15.	Eyes without true orbits. Eyestalks very short or obsolescent, concealed beneath a supraocular spine or sunk in the sides of a large rostrum (Acanthonychinae)	*Menaethius monoceros* p. 410
	Orbits partly defined. Postocular process present, hollowed for the partial retraction of the short eyestalks (Pisinae)	16.
	Orbits complete enough to entirely conceal the cornea dorsally (Maiinae)	17.
16.	Rostral spines long and divergent, separate from their base	*Hyastenus planasius* p. 411
	Rostral spines short, fused in their basal half ...	*Doclea gracilipes* p. 412
17.	Carapace armed with five long spines in the middle line. Rostral spines long and divergent, simple	*Paramithrax* (*Chlorinoides*) *aculeatus* p. 413
	Carapace with tubercles, but without spines, in the middle line. Rostral spines short, each with a small accessory spine on its outer border ...	*Schizophrys aspera* p. 414

18.	Carapace broadly triangular, not laterally expanded	*Lambrus* (*Platylambrus*) *prensor* p. 415
	Carapace pentagonal, with large lateral vaulted expansions which completely conceal the legs	*Cryptopodia angulata* p. 415
19.	Palp of external maxillipeds inserted at or near the antero-internal angle of the merus. Carapace usually transversely oval	20.
	Palp of external maxillipeds inserted at the summit of the antero-external angle of the merus. Carapace usually squarish	47.
20.	Last pair of legs flattened for swimming (Portunidae)	21.
	Last pair of legs not flattened (Goneplacidae and Xanthidae)	28.
21.	Antero-lateral borders of carapace cut into nine teeth	22.
	Antero-lateral borders of carapace cut into six teeth (*Charybdis*)	24.
	Antero-lateral borders of carapace cut into five teeth (*Thalamita*)	27.
22.	Teeth on antero-lateral borders equal in size	*Scylla serrata* p. 416
	Last tooth on antero-lateral borders enlarged in the form of a long spine (*Neptunus*)	23.
23.	No spine on the posterior border of the arm of the chelipeds	*Neptunus* (*Neptunus*) *sanguinolentus* p. 417
	A spine at the far end of the posterior border of the arm of the chelipeds	*Neptunus* (*Neptunus*) *pelagicus* p. 418
24.	No spine on the posterior border of the arm of the chelipeds (subgenus *Goniosoma*)	25.
	A spine at the end of the posterior border of the arm of the chelipeds	*Charybdis* (*Goniohellenus*) *hoplites* p. 423
25.	Teeth on antero-lateral borders subequal in size. Large or medium-sized crabs	26.
	Last tooth on antero-lateral borders longer than the rest. Small crabs	*Charybdis* (*Goniosoma*) *callianassa* p. 421
	Second tooth on carapace rudimentary	*Charybdis* (*Goniosoma*) *orientalis* p. 422
26.	First tooth on antero-lateral borders anteriorly truncated and notched. Sixth abdominal tergum of male with curved and gradually convergent sides. One or two inconspicuous denticles near the far end of the posterior border of the propodites of the last pair of legs. A brown cross on the carapace	*Charybdis* (*Goniosoma*) *cruciata* p. 419
	First tooth on the antero-lateral borders acute. Sixth abdominal tergum of the male with its sides parallel or even slightly divergent. Posterior border of the propodites of the last pair of legs strongly serrated throughout. Four whitish spots on the carapace	*Charybdis* (*Goniosoma*) *lucifera* p. 420
	First tooth on the antero-lateral borders acute. Sixth abdominal tergum of male with its sides parallel. Posterior border of propodites of last pair of legs serrated in a large part of its extent. Legs with annular bands	*Charybdis* (*Goniosoma*) *annulata* p. 420

27.	Teeth on antero-lateral borders subequal in size	*Thalamita crenata* p. 423
	Fourth tooth on antero-lateral borders rudimentary	*Thalamita prymna* p. 424
28 A.	(part, family Goneplacidae) :	
	Carapace hairy, edge of front distinctly curved	29.
	Carapace not hairy, edge of front cut straight and square	*Eucrate crenata dentata* p. 437
28 B.	(part, family Xanthidae) :	
	Ridges defining the efferent branchial channels either absent, or confined to the posterior part of the buccal cavity (Hyperolissa)	30.
	Ridges defining the efferent branchial channels continued up to the anterior border of the buccal cavity (Hyperomerista)	41.
29.	Antero-lateral borders with three teeth	*Litocheira angustifrons* p. 438
	Antero-lateral borders with two teeth	*Litocheira setosa* p. 439
30.	The front and antero-lateral borders form a convex arch, postero-lateral borders strongly convergent. Male abdomen with five segments (segments 3–5 fused)	31.
	Carapace nearly quadrilateral (arch of front and antero-lateral borders less convex). Male abdomen with seven segments	*Galene bispinosa* p. 431
31.	Carapace convex both fore and aft, and from side to side	32.
	Carapace convex fore and aft, flat from side to side	37.
32.	Antero-lateral borders entire, crested	33.
	Antero-lateral borders cut into teeth, not crested	36.
33.	Carapace smooth, hardly any indication of regions (*Atergatis*)	34.
	Carapace granular, regions well indicated	*Platypodia cristata* p. 427
34.	Edges of antero-lateral borders sharp, forming a ridge at the lateral epibranchial angles	35.
	Edges of antero-lateral borders thick and blunt, without any ridge	*Atergatis roseus* p. 426
35.	Carapace with a smooth, even surface	*Atergatis integerrimus* p. 425
	Carapace with the surface lumpy	*Atergatis floridus* p. 426
36.	Fingers of chelipeds with broad, hoof-like extremities	*Etisus lævimanus* p. 431
	Fingers of chelipeds pointed	*Actaea savignyi* p. 432
37.	Antero-lateral borders prolonged beneath the orbit to the angle of the buccal cavity	*Medaeus granulosus* p. 430
	Antero-lateral borders not prolonged beyond the orbit	38.
38.	Fingers of chelipeds blunt-tipped (*Leptodius*)	39.
	Fingers of chelipeds sharp	*Xantho* (*Lophoxanthus*) *scaberrimus baccalipes* p. 427
39.	Five teeth on antero-lateral borders	*Leptodius crassimanus* p. 429
	Four teeth on antero-lateral borders	40.
40.	Carapace only slightly areolated	*Leptodius exaratus* p. 428
	Carapace completely areolated (as in *Actaea*)	*Leptodius euglyptus quadrispinosus* p. 429
41.	Fronto-orbital border half, or less than half, the greatest breadth of the carapace	42.
	Fronto-orbital border just ⅔rd the greatest breadth of the carapace	44.
	Fronto-orbital border more than ¾th the greatest breadth of the carapace	*Eriphia laevimana smithii* p. 437

42. Basal antennal joint not reaching the front ... *Myomenippe hardwickii* p. 432
Basal antennal joint broadly in contact with front ... ... 43.
43. Antero-lateral borders thin and sharp ... *Epixanthus frontalis* p. 434
Antero-lateral borders not thin and sharp ... *Ozius rugulosus* p. 433
44. Carapace hairy, regions well defined (*Pilumnus*). 45.
Carapace not tomentose, regions ill defined ... 46.
45. A subhepatic spine, just below the outer orbital angle ... ... *Pilumnus vespertilio* p. 434
No subhepatic spine ... ... *Pilumnus longicornis* p. 435
46. Indications of areolation on the carapace anteriorly, front bilobed ... *Heteropanope laevis* p. 436
Carapace without any trace of regions, front cut straight and square ... ... *Eurycarcinus orientalis* p. 436
47. Small crabs living as commensals, mostly in bivalve molluscs (Pinnotheridae) ... 48.
Free living crabs ... ... 49.
48. Dactylus of external maxillipeds in the female does not extend to the apex of the propodite. Dactyli of third and fourth legs in the female $1\frac{1}{4}$ times as long as those of the first and second. Colour pink ... ... *Pinnotheres placunae* p. 503
Dactylus of external maxillipeds in the female reaches to the end of the propodite. Dactyli of third and fourth legs in the female twice as long as those of the first two. Colour yellow ... *Pinnotheres vicajii* p. 505
49. Orbits wider, often much wider, than front. External maxillipeds meeting, or nearly so, in the middle line. Carapace squarish or transversely oblong (Ocypodidae) ... ... 50.
Front at least as wide as, usually wider than, orbit. A large, rhomboidal gap between the external maxillipeds. Carapace square (Grapsidae) ... ... 62.
50. A hairy-edged pouch between the bases of the second and third pairs of legs (Ocypodinae) ... 51.
No pouch between the second and third pairs of legs ... ... 57.
51. Chelipeds slightly unequal in both sexes. Cornea large, ventral, occupying the greater part of the surface of the eyestalks (*Ocypoda*) ... 52.
Chelipeds in the female equal and small; in the male one is vastly larger than the other. Eyes small, terminal on the long slender eyestalks (*Gelasimus*) ... ... 54.
52. A stridulating ridge on the inner surface of the palm. Eyestalks prolonged beyond the eyes as a style ... ... 53.
No stridulating ridge on the palm. Eyestalks not prolonged beyond the eyes ... ... *Ocypoda cordimana* p. 507
53. Antero-lateral angles of carapace pronounced ... *Ocypoda ceratophthalma* p. 506
Antero-lateral angles of carapace rounded ... *Ocypoda rotundata* p. 508
54. Front $\frac{1}{5}$th to $\frac{1}{6}$th the greatest breadth of the carapace ... ... *Gelasimus annulipes* p. 508
Front less than $\frac{1}{15}$th the greatest breadth of the carapace ... ... 55.
55. Inner border of the arm of the larger male cheliped ends in a sharp tooth or spine ... 56.

	Arm of the larger male cheliped ends in a constricted lobe, but there is no sharp tooth on its inner border	*Gelasimus dussumieri* p. 510
56.	Cutting edge of the thumb of the cheliped with a single, smooth curve	*Gelasimus marionis* p. 509
	Cutting edge of the thumb of the cheliped scalloped into two lobes	*Gelasimus marionis nitidus* p. 510
57.	Membranous spaces (tympana) on meropodites of legs. Fourth abdominal segment of male fringed with bristles	*Dotilla myctiroides* p. 511
	No tympana on legs. Abdomen normal (Macrophthalminae)	58.
58.	Eyestalks projecting beyond the antero-lateral angles of the carapace	*Macrophthalmus sulcatus* p. 513
	Eyestalks not projecting beyond the antero-lateral angles of the carapace	59.
59.	Sides of carapace convergent posteriorly ...	*Macrophthalmus pectinipes* p. 512
	Sides of carapace divergent posteriorly ...	*Macrophthalmus pacificus* p. 514
	Sides of carapace parallel	60.
60.	Four teeth on the lateral borders of the carapace	*Macrophthalmus latreillei* p. 513
	Three teeth on the lateral borders of the carapace	61.
61.	Carapace ⅔rd as long as broad. Front ⅐th the breadth of the carapace	*Macrophthalmus depressus* p. 514
	Carapace ¾ths as long as broad. Front ¼th the breadth of the carapace	*Macrophthalmus crinitus* p. 515
62.	Antennules fold beneath the front in the usual manner	63.
	Antennules fold longitudinally in deep notches in the front, visible dorsally	*Plagusia depressa tuberculata* p. 523
63.	No oblique hairy ridge on the external maxillipeds	64.
	An oblique hairy ridge on the external maxillipeds	68.
64.	A very wide gap between the third maxillipeds, exopodites of these narrow. Male abdomen occupying all the space between the bases of the last legs (Grapsinae)	65.
	A moderate gap between the third maxillipeds, exopodites of these broad. Male abdomen does not occupy the whole space between the bases of the last pair of legs (Varuninae) ...	67.
65.	Front less than half the greatest breadth of the carapace	*Grapsus strigosus* p. 515
	Front more than half the greatest breadth of the carapace (*Metopograpsus*)	66.
66.	Front not laminar, sinuous. Fine transverse markings on the post-frontal region. Last segment of male abdomen triangular ...	*Metopograpsus messor* p. 516
	Front straight and laminar. No transverse markings on the post-frontal region. Last segment of male abdomen three-lobed ...	*Metopograpsus maculatus* p. 517

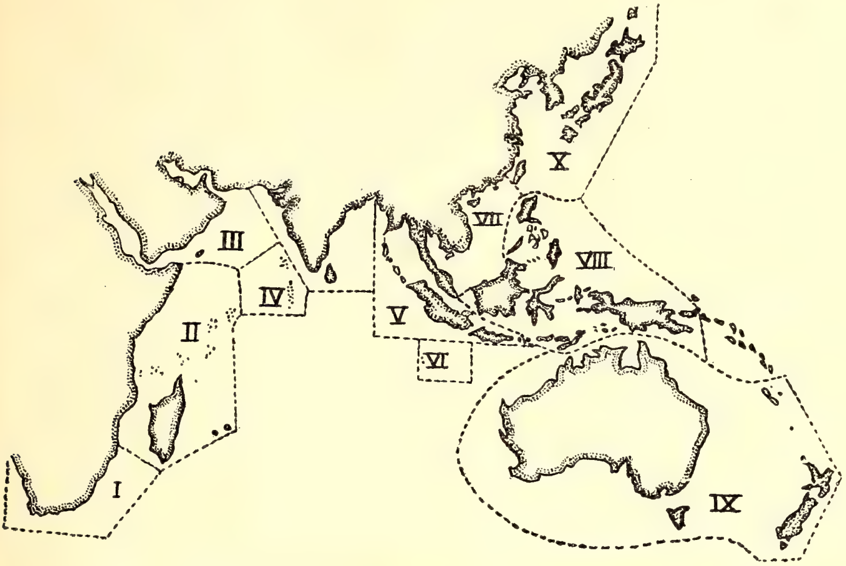
67.	Last three joints of legs compressed and plumed for swimming. No fleshy lobe at the base of the fingers of the chelipeds ...	*Varuna litterata*	p. 518
	Legs hairy but not compressed. A fleshy lobe at the base of the fingers of the chelipeds ...	*Pseudograpsus intermedius*	p. 519
68.	Carapace nearly square. Pterygostomian regions with a sieve-like reticulation (*Sesarma*) ...	69.	
	Carapace much broader than long. No reticulation on the pterygostomian regions (*Metaplax*).	70.	
69.	No teeth on the lateral borders behind the orbital angles. Two oblique pectinated ridges on the palms of the male chelipeds. Upper surface of the dactylus in the male with a milled ridge of 11–19 lamellae	*Sesarma* (*Sesarma*) *quadrata*	p. 520
	One tooth on the lateral borders behind the orbital angles. One pectinated ridge on the palms of the chelipeds. A milled crest with 40–60 teeth on the dactylus of the male ...	*Sesarma* (*Sesarma*) *taeniolata*	p. 521
	Two teeth on the lateral borders behind the orbital angles. A granular (not pectinate) ridge on the palms of the chelipeds. Dactylus without any milled ridge	*Sesarma* (*Sesarma*) *oceanica*	p. 520
	One tooth on the lateral borders behind the orbital angles. No pectinate crests on the palms of the chelipeds. Posterior borders of the meropodites of the legs serrated near the carpus. Extremely small crabs	*Sesarma* (*Sesarma*) *minuta*	p. 522
70.	Third to fifth segments of the male abdomen fused	*Metaplax indica*	p. 522
	Male abdomen with seven separate segments ...	*Metaplax distincta*	p. 523

Geographic Distribution of Crabs occurring in the Bombay State, in the Indo-Pacific Region

The foregoing taxonomic account records 81 species and subspecies of crabs from different localities in the Bombay State. Perusal of similar account of crabs from different maritime countries of the Indo-Pacific region indicates that many of these species occur over an extensive range and are common in several areas in the region. Such wide geographic distribution is natural in marine crabs where inter-connecting oceans do not serve as barriers to dispersal except the thermal differences to some extent. It is, therefore, interesting to note what species and percentage of the total Brachyuran fauna of this State occur in other areas of the Indo-Pacific region. These are indicated below in Tables I and II.

The scattered localities where these species occur have been recorded by several authors such as Laurie (1907-1915), Barnard (1950), Borradaile (1902-1903), Estampador (1937), Tweedie (1935-1950), Miers (1876), Haswell (1882), Sakai (1936-1939), Shen (1931-1948), etc., in the Indo-Pacific region. While studying the Brachyuran fauna of the Australian coast, Montgomery had arbitrarily divided this region into several zones.

The same system of dividing regions has been followed here with a few modifications to suit the present study. The zones are as under :—



Text-figure 3. Map showing the different geographical areas in the Indo-Pacific Region with which the Crabs of the Bombay Coast have been compared.

I. South Africa.
II. East Coast of Africa, Madagascar, Mauritius, and Seychelles I.
III. Red Sea, Persian Gulf.
IV. Laccadives and Maldives.
V. Burma, Tavoy and Mergui, the Andaman and Nicobar Is., Indonesia and Singapore.
VI. Cocos-Keeling and Christmas Is.
VII. Thailand, South China Sea.
VIII. Philippines.
IX. Australia (including Torres Straits).
X. Japan, China.

Out of the 81 species and subspecies, three are new to science, and the geographic distribution of the remaining species can be studied from the table. It will be seen that 21 species occurring on the coasts of Bombay State are widely distributed throughout the Indo-Pacific region, ranging from South Africa in the west to Australia in the east. Eight species, though not occurring in South Africa, are found from the east coast of Africa to Australia. Nine species do not occur outside India and appear to be strictly confined to this region. Three species, viz. *Gelasimus annulipes* Latreille, *Plagusia depressa tuberculata* (Lamarck), and possibly *Grapsus strigosus* (Herbst), extend to the west coast of America. The occurrence of these leads us to another problem of distribution. Sewell (1947) states : ' Ocean currents provide a means of transportation for both bottom-dwelling and pelagic animals. Floating weeds and logs of wood

TABLE I

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Dromia dormia (Linnaeus) ...	–	+	+	+	+	–	–	–	+	+
Pseudodromia integrifrons Henderson ...	–	+	+	–	+	–	+	–	+	+
Calappa lophos (Herbst) ...	–	+	+	–	+	–	+	–	+	+
Matuta lunaris (Forskal) ...	–	+	+	–	+	–	+	+	+	+
Matuta planipes Fabricius...	–	–	–	–	+	–	+	+	+	+
Leucosia pubescens Miers ...	–	–	+	–	+	–	+	–	+	–
Leucosia sima Alcock ...	–	–	+	–	–	–	–	–	–	–
Philyra globosa (Fabricius)...	–	–	–	–	+	–	–	–	+	–
Philyra corallicola Alcock...	–	–	–	–	–	–	–	–	–	–
Arcania septemspinosa (Fabricius)	–	–	+	–	+	–	+	–	–	+
Dorippe astuta Fabricius ...	–	–	–	–	+	–	+	+	+	–

Elamena cristatipes Gravely	–	–	–	–	–	–	–	–	–	–
Menaethius monoceros Latreille	+	+	+	+	+	+	+	+	+	+
Hyastenus planasius (Adams and White)	–	–	–	–	+	–	+	–	–	–
Doclea gracilipes Stimpson...	–	–	–	–	+	–	+	–	–	–
Paramithrax (*Chlorinoides*) *aculeatus* (Milne-Edwards)	–	–	–	–	+	–	+	–	+	–
Schizophrys aspera (Milne-Edwards)	+	+	+	+	+	+	–	–	+	+
Lambrus (*Platylambrus*) *prensor* Herbst ...	–	–	–	–	+	–	–	–	–	–
Cryptopodia angulata Milne-Edwards and Lucas ...	–	–	–	–	–	–	–	–	–	–
Scylla serrata (Forskal)	+	+	+	–	+	–	+	+	+	+
Neptunus (*Neptunus*) *sanguinolentus* (Herbst) ...	+	+	+	–	+	–	+	+	+	+
Neptunus (*Neptunus*) *pelagicus* (Linnaeus) ...	+	+	+	–	+	–	+	+	+	+
Charybdis (*Goniosoma*) *cruciata* (Herbst) ...	+	–	–	–	+	–	+	+	+	+
Charybdis (*Goniosoma*) *lucifera* (Fabricius) ...	–	–	–	–	+	–	+	–	–	+
Charybdis (*Goniosoma*) *annulata* (Fabricius) ...	+	+	–	–	+	–	+	–	–	+

TABLE I

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Dromia dormia (Linnaeus) ...	−	+	+	+	+	−	−	−	+	+
Pseudodromia integrifrons Henderson ...	−	+	+	−	+	−	+	−	+	+
Calappa lophos (Herbst) ...	−	+	+	−	+	−	+	−	+	+
Matuta lunaris (Forskal) ...	−	+	+	−	+	−	+	+	+	+
Matuta planipes Fabricius...	−	−	−	−	+	−	+	+	+	+
Leucosia pubescens Miers ...	−	−	+	−	+	−	+	−	+	−
Leucosia sima Alcock ...	−	−	+	−	−	−	−	−	−	−
Philyra globosa (Fabricius)...	−	−	−	−	+	−	−	−	+	−
Philyra corallicola Alcock...	−	−	−	−	−	−	−	−	−	−
Arcania septemspinosa (Fabricius)	−	−	+	−	+	−	+	−	−	+
Dorippe astuta Fabricius ...	−	−	−	−	+	−	+	+	+	−
Elamena cristatipes Gravely	−	−	−	−	−	−	−	−	−	−
Menaethius monoceros Latreille	+	+	+	+	+	+	+	+	+	+
Hyastenus planasius (Adams and White)	−	−	−	−	+	−	+	−	−	−
Doclea gracilipes Stimpson...	−	−	−	−	+	−	+	−	−	−
Paramithrax (*Chlorinoides*) *aculeatus* (Milne-Edwards)	−	−	−	−	+	−	+	−	+	−
Schizophrys aspera (Milne-Edwards)	+	+	+	+	+	+	−	−	+	+
Lambrus (*Platylambrus*) *prensor* Herbst ...	−	−	−	−	+	−	−	−	−	−
Cryptopodia angulata Milne-Edwards and Lucas ...	−	−	−	−	−	−	−	−	−	−
Scylla serrata (Forskal)	+	+	+	−	+	−	+	+	+	+
Neptunus (*Neptunus*) *sanguinolentus* (Herbst) ...	+	+	+	−	+	−	+	+	+	+
Neptunus (*Neptunus*) *pelagicus* (Linnaeus) ...	+	+	+	−	+	−	+	+	+	+
Charybdis (*Goniosoma*) *cruciata* (Herbst) ...	+	−	−	−	+	−	+	+	+	+
Charybdis (*Goniosoma*) *lucifera* (Fabricius) ...	−	−	−	−	+	−	+	−	−	+
Charybdis (*Goniosoma*) *annulata* (Fabricius) ...	+	+	−	−	+	−	+	−	−	+

TABLE I—(*Contd.*)

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Charybdis (*Goniosoma*) *callianassa* (Herbst) ...	–	–	–	–	+	–	+	–	–	–
Charybdis (*Goniosoma*) *orientalis* (Dana)	+	–	+	–	–	–	+	+	–	+
Charybdis (*Goniohellenus*) *hoplites* (Wood-Mason) ...	–	+	–	–	–	–	–	–	–	–
Thalamita crenata Milne-Edwards	+	+	+	–	+	+	+	+	+	+
Thalamita prymna (Herbst)	+	+	+	+	+	–	+	+	+	+
Atergatis integerrimus (Lamarck)	–	+	–	–	+	–	+	+	–	+
Atergatis floridus (Rumph)...	+	+	+	+	+	–	+	+	+	+
Atergatis roseus (Ruppell) ...	+	+	+	–	+	–	–	–	+	–
Platypodia cristata (Milne-Edwards)	–	+	+	+	–	+	–	–	–	–

Xantho (*Lophoxanthus*) *scaberrimus baccalipes* Alcock	—	—	—	—	—	—	—	—	—	—
Leptodius exaratus (Milne-Edwards)	—	+	+	—	+	—	+	+	+	+
Leptodius crassimanus Milne-Edwards	—	—	—	—	+	—	—	—	+	—
Medaeus granulosus (Haswell)	+	—	+	—	+	—	+	—	+	+
Etisus laevimanus Randall	—	+	+	+	+	+	—	+	+	+
Galene bispinosa (Herbst) ...	—	—	—	—	+	—	—	—	—	+
Actaea savignyi (Milne-Edwards)	+	+	+	+	+	—	+	—	+	+
Myomenippe hardwickii (Gray)	—	+	—	—	+	—	+	—	—	—
Ozius rugulosus Stimpson ...	—	—	+	—	+	—	—	—	—	+
Epixanthus frontalis (Milne-Edwards)	—	+	+	—	+	—	+	+	+	+
Pilumnus vespertilio (Fabricius)	—	+	+	—	+	—	—	—	—	—
Pilumnus longicornis Hilgendorf	—	+	—	—	—	—	+	—	—	+
Heteropanope laevis (Dana)	—	—	—	—	—	—	—	—	—	—
Eurycarcinus orientalis (Milne-Edwards) ...	—	—	—	—	+	—	+	—	—	—

TABLE I—(*Contd.*)

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Charybdis (*Goniosoma*) *callianassa* (Herbst) ...	−	−	−	−	+	−	+	−	−	−
Charybdis (*Goniosoma*) *orientalis* (Dana)	+	−	+	−	−	−	+	+	−	+
Charybdis (*Goniohellenus*) *hoplites* (Wood-Mason) ...	−	+	−	−	−	−	−	−	−	−
Thalamita crenata Milne-Edwards	+	+	+	−	+	+	+	+	+	+
Thalamita prymna (Herbst)	+	+	+	+	+	−	+	+	+	+
Atergatis integerrimus (Lamarck)	−	+	−	−	+	−	+	+	−	+
Atergatis floridus (Rumph) ...	+	+	−	+	+	−	+	+	+	+
Atergatis roseus (Ruppell) ...	+	+	+	−	+	−	−	−	+	−
Platypodia cristata (Milne-Edwards)	−	+	+	+	−	+	−	−	−	−
Xantho (*Lophoxanthus*) *scaberrimus baccalipes* Alcock	−	−	−	−	−	−	−	−	−	−
Leptodius exaratus (Milne-Edwards)	−	+	+	−	+	−	+	+	+	+
Leptodius crassimanus Milne-Edwards	−	−	−	−	+	−	−	−	+	−
Medaeus granulosus (Haswell)	+	−	+	−	+	−	+	−	+	+
Etisus laevimanus Randall	−	+	+	+	+	+	−	+	+	+
Galene bispinosa (Herbst) ...	−	−	−	−	+	−	−	−	−	+
Actaea savignyi (Milne-Edwards)	+	+	+	+	+	−	+	−	+	+
Myomenippe hardwickii (Gray)	−	+	−	−	+	−	+	−	−	−
Ozius rugulosus Stimpson ...	−	−	+	−	+	−	−	−	−	+
Epixanthus frontalis (Milne-Edwards)	−	+	+	−	+	−	+	+	+	+
Pilumnus vespertilio (Fabricius)	−	+	+	−	+	−	−	−	−	−
Pilumnus longicornis Hilgendorf	−	+	−	−	−	−	+	−	−	+
Heteropanope laevis (Dana)	−	−	−	−	−	−	−	−	−	−
Eurycarcinus orientalis (Milne-Edwards) ...	−	−	−	−	+	−	+	−	−	−

TABLE I—(*Contd.*)

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Eriphia laevimana smithii Macleay	–	+	+	–	+	–	+	–	+	+
Eucrate crenata dentata (Stimpson)	–	–	+	–	–	–	+	–	–	–
Litocheira angustifrons Alcock	–	–	–	+	+	–	–	–	–	–
Litocheira setosa (Milne-Edwards)	–	–	–	–	+	–	+	–	–	–
Pinnotheres placunae Hornell and Southwell ...	–	–	–	–	–	–	–	–	–	–
Ocypoda ceratophthalma (Pallas)	+	+	+	–	+	+	+	+	+	+
Ocypoda cordimana Desmarest	+	+	+	+	+	+	–	+	+	+
Ocypoda rotundata Miers ...	–	–	–	–	–	–	–	–	–	–

Gelasimus annulipes Latreille	+	+	+	—	+	—	+	+	+	+
Gelasimus marionis (Desmarest)	+	+	+	—	+	—	+	+	+	+
Gelasimus marionis nitidus Dana	+	+	+	—	+	—	+	+	+	+
Gelasimus dussumieri Milne-Edwards	—	—	—	—	+	—	+	+	+	—
Dotilla myctiroides (Milne-Edwards)	—	—	—	—	+	—	—	—	—	—
Macrophthalmus pectinipes Guerin	—	—	—	—	+	—	—	—	—	—
Macrophthalmus sulcatus Milne-Edwards ...	+	+	—	—	+	—	—	—	+ ?	—
Macrophthalmus latreillei Desmarest	—	+	—	—	+	—	+	+	+	+
Macrophthalmus depressus Ruppel	—	—	+	—	—	—	—	—	+ ?	—
Macrophthalmus crinitus Rathbun	—	—	—	—	+	—	+	—	—	—
Macrophthalmus pacificus Dana	—	—	—	—	+	—	—	—	+	—
Grapsus strigosus (Herbst) ...	+	+	+	—	+	+	+	+	+	+
Metopograpsus messor (Forskal)	+	+	+	—	+	—	+	+	+	+

TABLE I—(*Contd.*)

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Eriphia laevimana smithii Macleay	–	+	+	–	+	–	+	–	+	+
Eucrate crenata dentata (Stimpson)	–	–	+	–	–	–	+	–	–	–
Litocheira angustifrons Alcock	–	–	–	+	+	–	–	–	–	–
Litocheira setosa (Milne-Edwards)	–	–	–	–	+	–	+	–	–	–
Pinnotheres placunae Hornell and Southwell	–	–	–	–	–	–	–	–	–	–
Ocypoda ceratophthalma (Pallas)	+	+	+	–	+	+	+	+	+	+
Ocypoda cordimana Desmarest	+	+	+	+	+	+	–	+	+	+
Ocypoda rotundata Miers	–	–	–	–	–	–	–	–	–	–
Gelasimus annulipes Latreille	+	+	+	–	+	–	+	+	+	+
Gelasimus marionis (Desmarest)	+	+	+	–	+	–	+	+	+	+
Gelasimus marionis nitidus Dana	+	+	+	–	+	–	+	+	+	+
Gelasimus dussumieri Milne-Edwards	–	–	–	–	+	–	+	+	+	–
Dotilla myctiroides (Milne-Edwards)	–	–	–	–	+	–	–	–	–	–
Macrophthalmus pectinipes Guerin	–	–	–	–	+	–	–	–	–	–
Macrophthalmus sulcatus Milne-Edwards	+	+	–	–	+	–	–	–	+ ?	–
Macrophthalmus latreillei Desmarest	–	+	–	–	+	–	+	+	+	+
Macrophthalmus depressus Ruppel	–	–	+	–	–	–	–	–	+ ?	–
Macrophthalmus crinitus Rathbun	–	–	–	–	+	–	+	–	–	–
Macrophthalmus pacificus Dana	–	–	–	–	+	–	–	–	+	–
Grapsus strigosus (Herbst)	+	+	+	–	+	+	+	+	+	+
Metopograpsus messor (Forskal)	+	+	+	–	+	–	+	+	+	+

TABLE I—(*Contd.*)

Forms from the coast of Bombay State described in the present paper	South Africa	East coast of Africa, Madagascar, Mauritius, Seychelles I.	Red Sea, Persian Gulf	Laccadives and Maldives	Burma, Tavoy and Mergui, Andaman and Nicobar Is., Indonesia, Singapore	Cocos-Keeling and Christmas Is.	Thailand, South China Sea	Philippines	Australia	Japan, China
Metopograpsus maculatus Milne-Edwards ...	—	—	—	—	+	—	—	+	—	—
Varuna litterata (Fabricius)	+	+	—	—	+	—	+	+	+	+
Sesarma (Sesarma) quadrata (Fabricius)	—	+	—	—	+	—	—	+	—	+
Sesarma (Sesarma) oceanica de Man	—	—	—	—	+	—	—	—	—	—
Sesarma (Sesarma) taeniolata White	—	—	—	—	+	—	+	+	—	—
Sesarma (Sesarma) minuta de Man	—	—	—	—	+	—	—	—	—	—
Metaplax indica Milne-Edwards	—	—	—	—	—	—	—	—	—	—
Metaplax distincta Milne-Edwards	—	—	—	—	+	—	—	—	—	—
Plagusia depressa tuberculata (Lamarck)	+	+	+	+	+	+	+	+	+	+

may be carried along with ocean currents and the forms that cling to them are also taken along with them. Thus weed-clinging littoral forms may be carried away and dispersed widely.' Chilton (1910) has also called attention to the role of the movements of ships in the dispersal of larger Crustacea like crabs and Amphipoda, and remarks: 'Naturally, the Crustaceans that are suitable for dispersal by ships can also be dispersed by floating logs; in that case, however, they would follow the tracks of the prevailing currents.' The accidental transport of these foreign species taken from harbours where foreign ships dock for several weeks cannot have any geographic significance of scientific value.

The homogeneity of the Indo-Pacific Brachyuran fauna has been stressed by Laurie (1915), who states: 'The homogeneity of the Indo-Pacific region is illustrated by the fact that in places so far apart as Seychelles and Hawaii the percentage of crabs common to the Red Sea is very similar, approximately 33% in each case, that this percentage occurs at Ceylon and a fairly similar one at the Maldives and Laccadives. India is below, and Torres Straits distinctly above, this average figure.* His conclusion is that 'the Indo-Pacific figures suggest that one may prophesy with a probable error of ± 5 or 6 that 35 is the most likely percentage of species common to the Red Sea which will be found in a collection of...... crabs from hitherto unexplored, or insufficiently explored, portion of the Indo-Pacific region.'

The Bombay State crab fauna gives a percentage of 43, which is somewhat high.

It will be noted from the table that the different families of crabs vary considerably in the 'percentage of homogeneity'; this may be noted also in Laurie's table. The Xanthidae, as might be expected, are above the average, and the Portunidae come next. It may be remarked, too, that it is the extremely widespread species which bring the percentage of homogeneity up.

Table II deals with the percentage of homogeneity of the different families of Brachyura as occurring in Bombay State and in India.

OBSERVATIONS ON ECOLOGICAL ADAPTATIONS

Observations on the natural habitats of crabs indicate that they are found in a variety of ecological conditions and manifest interesting morphological and physiological adaptations to suit their varying environments. The different tribes and families can be grouped according to the environmental conditions in which they live and to which they respond.

The majority of crabs are marine, but many can tolerate brackish water; others live in entirely fresh water, while a considerable number are amphibious, living partly on land and partly in water. Most of the marine crabs inhabit littoral and shallow water, but many others live at great depths.

The shore crabs display the widest range of variation in their adaptations. Some of the extreme adaptations are almost inexplicable, but most of them are elucidated below in relation to their ecological significance, and the part they play in preserving and perpetuating the species.

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* In estimating the significance of these percentages, it should be remembered that some areas having been fairly explored are a good standard; on the other hand, other populations may have been sampled under different conditions.

TABLE II

Tribe/Family	Red Sea species (based on Laurie)	Total Indian species (based on Alcock)	Number common to Red Sea	Percentage common to Red Sea	Total Bombay species (based on the present paper)	Number common to Red Sea	Percentage common to Red Sea
Oxystomata	30	113	17	15	9	5	55
Calappidae	5	15	5	33	3	2	67
Leucosiidae	23	82	10	12	5	3	60
Dorippidae	1	11	1	9	1	0	0
Raninidae	1	5	1	20	...	...	...
Dromiacea	8	29	6	20	2	1	50
Dromiidea	8	21	6	28	2	1	50
Homolodromiidae ...	...	1	0	0	...	...	...
Dromiidae	8	18	6	33	2	1	50
Dynomenidae	...	2	0	0	...	...	...
Homolidea	...	8	0	0	...	...	...
Homolidae	...	6	0	0	...	...	...
Latreillidae	...	2	0	0	...	...	...
Brachygnatha	222	459	117	25	70	28	28
Oxyrhyncha	34	112	18	16	8	2	25
Hymenosomidae ...	1	5	0	0	1	0	0

Maiidae	22	76	13	17	5	2	40
Parthenopidae	11	31	5	16	2	0	0
Brachyrhyncha ...	188	347	99	28	63	26	41
Corystidae	...	1	0	0	...	...	...
Portunidae	35	63	22	34	11	6	54
Potamonidae	...	...	...	...	4	...	...
Atelecyclidae	...	4	0	0	...	...	...
Trichiidae	...	...	...	...	...	...	...
Cancridae	...	...	...	...	...	...	...
Xanthidae	107	147	56	38	19	11	58
Goneplacidae	5	29	3	10	3	1	33
Pinnotheridae	12	11	1	9	1	...	...
Ptenoplacidae	...	1	0	0	...	...	...
Palicidae	2	5	2	40	...	...	...
Grapsidae	11	48	6	12	11	3	30
Gecarcinidae	...	5	0	0	...	...	...
Ocypodidae	15	33	9	27	14	5	36
Hapalocarcinidae ...	1	...	...	...	...	...	...
Total species ...	260	601	140	23	81	35	43

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Raninidae	1	5	1	20	...	...	...
Dromiacea	8	29	6	20	2	1	50
Dromiidea	8	21	6	28	2	1	50
Homolodromiidae ...	...	1	0	0	...	...	...
Dromiidae	8	18	6	33	2	1	50
Dynomenidae	...	2	0	0	...	...	...
Homolidea	...	8	0	0	...	...	..
Homolidae	...	6	0	0	...	...	...
Latreillidae	...	2	0	0	...	...	...
Brachygnatha	222	459	117	25	70	28	28
Oxyrhyncha	34	112	18	16	8	2	25
Hymenosomidae ...	1	5	0	0	1	0	0
Maiidae	22	76	13	17	5	2	40
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Brachyrhyncha ...	188	347	99	28	63	26	41
Corystidae	...	1	0	0	...	...	...
Portunidae	35	63	22	34	11	6	54
Potamonidae	...	...	...	...	4	...	...
Atelecyclidae	...	4	0	0	...	...	...
Trichiidae	...	...	...	...	...	..	...
Cancridae	...	...	...	...	...	...	...
Xanthidae	107	147	56	38	19	11	58
Goneplacidae	5	29	3	10	3	1	33
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Ptenoplacidae	...	1	0	0	...	...	...
Palicidae	2	5	2	40	...	...	...
Grapsidae	11	48	6	12	11	3	30
Gecarcinidae	...	5	0	0	...	...	...
Ocypodidae	15	33	9	27	14	5	36
Hapalocarcinidae ...	1	...	...	...	...	...	...
Total species ...	260	601	140	23	81	35	43

The spider-crabs (Oxyrhyncha) comprise a group by themselves, a majority of them being adapted specially for life amongst weeds, mostly in the inter-tidal zone. They are sluggish and inoffensive and depend for their survival on camouflage. They are curiously coloured and sculptured so as to resemble the patterns of broken shells and eroded rocks among which they live. Their bodies are specially adapted for gathering weeds and small organisms, being provided with knob-like processes, hooks, and spines, on which algae, sponges, worms, etc. can get a hold. Alcock (1901) states: ' Some species purposely attach pieces of seaweed and fragments of shell on their bodies so as to escape notice.' They have long, tapering legs by which they can walk through entangled shore algae or cling tightly to the rocks or algae in which they dwell. They have no other defence and, when removed from their surroundings, quiver their legs helplessly. A typical example is *Paramithrax* (*Chlorinoides*) *aculeatus*.

Most of the Oxystomata are burrowing crabs. They live in sand or mud, some remaining buried till only their eyestalks show above the surface. Their carapace is coloured to blend with the sandy background. The Calappidae have peculiarly modified chelae. When held close to the body, the flattened claws together form a sort of buckler protecting the body (e.g. *Calappa lophos*). The Matutinae have all their legs modified to form paddles by means of which they swim with ease and speed (e.g. *Matuta lunaris*). The Leucosiidae are so coloured and shaped as to resemble pellets of mud so as to escape detection (e.g. *Leucosia pubescens*). Many of the Dorippidae carry about a house of their own by roofing themselves over with a shell, held by the last two pairs of legs (e.g. *Dorippe astuta*).

This peculiar habit is also common to the Dromiacea, or sponge-crabs, in which too the last two pairs of legs are usually adapted for holding a piece of sponge or shell over the body (e.g. *Dromia dormia*). They are primitive crabs, connecting the higher Brachyura with the Macrura.

The Portunidae, or swimming crabs, are pelagic forms, living either in open seas or in creeks or estuaries. They have the last pair of legs modified to form paddles, and they are active creatures. When swimming, they often hold one chela extended, and the other folded in, so that one might mistake them for a fish. They rely for defence on speed, but are also able to use their claws to great effect, and the larger forms are greatly feared by fishermen. They are also coloured slaty blue or grey, which is the general colour of sea-water below the surface [e.g. *Neptunus* (*Neptunus*) *pelagicus*].

The Xanthidae are mostly rock-dwellers, or live in mud under stones. Their carapace, which may be so convex as to be almost subglobular, or flat, is very strongly calcified. They are sluggish forms and, when disturbed, do not scuttle away. Although having powerful chelae, it is surprising that they do not use them. On being handled, they fold up their legs and chelae against the body, a position peculiar to the Xanthidae (e.g. *Ozius rugulosus*).

The Pinnotheridae are a peculiar group of crabs, living as commensals in the body-cavities of bivalves and Holothurians, undergoing degeneration. They are feeble crabs, with soft bodies and tiny eyes. The males may live freely or as commensals (e.g. *Pinnotheres placunae*).

The Ocypodinae are amphibious. They are gregarious and live close to the seashore in burrows, and can breathe air so long as their gill-chambers are moist, but die when forcibly submerged in water for a long time. They are some of the most intelligent of all the crabs. They are extremely fast and active on land, their speed equalling, if not exceeding, a running man's (e.g. *Ocypoda ceratophthalma*).

The Scopimerinae are soft, feeble crabs, living in colonies, burrowing in mud. They are also called ' soldier-crabs ', from their habit of ' marching in formation ' (e. g. *Dotilla myctiroides*).

The Macrophthalminae are pelagic or mud-dwellers.

The Grapsidae are rock-dwellers, mostly living on stone embankments. They are vigilant and intelligent creatures and trust to their speed and craft to escape their enemies, it being very difficult to pursue them (e.g. *Grapsus strigosus*). A member of their family, *Eriocheir sinensis*, is important in that its natural distribution is China, but it has colonized in Germany.

The Varuninae make their home on drift timber or drift seaweed, and are well adapted for swimming, this accounting for their wide distribution (e.g. *Varuna litterata*).

The size of the body in crabs is also extremely variable, exhibiting a wide range. In large specimens of *Scylla serrata*, the carapace attains a breadth of 211 mm. (or 8 inches), and the span of the chelipeds measures 810 mm., whereas the other extreme in size is met with in *Sesarma* (*Sesarma*) *minuta*, which has the tiniest carapace, the breadth of which, in the adult, is 3.2 mm.

In some crabs there are sufficiently well-marked ' secondary ' sexual characters, e.g. differences in the size and sculpture of the chelipeds of adult males and adult females or immature males (e.g. *Gelasimus annulipes*). Several genera (e.g. *Matuta*, *Ocypoda*, *Metaplax* male) possess organs of stridulation for attracting the opposite sex.

Crabs play an important role in nature's economy in two ways :

(1) They are one of the principal sources of food for numerous fishes (especially sting rays), frogs, crocodiles, swimming and wading birds, jackals, and other carnivorous animals, and last but not least, man.

(2) They are important as scavengers of the seashore, making up in numbers what they lack in size.

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INDIAN MARSILEAS: THEIR MORPHOLOGY AND SYSTEMATICS

2. On the Examination of Some Collections of *MARSILEA* in India

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[*Continued from Vol.* 53 (3): 444]

(*With* 48 *figures*)

Since the discovery of *Marsilea aegyptiaca* in India (3) the problem of the morphology and systematics of the genus *Marsilea* with particular reference to the Indian species has been taken up for a detailed investigation and some progress has already been made in that direction (6). Further as a result of closer studies of the material in Rajasthan, it has been not only possible to discover new material (4) but we find that the plants growing at different places, in somewhat different ecological surroundings, differ markedly in their morphological organisation; for instance there exist more than one variety of *M. minuta* in Jodhpur or Udaipur division of Rajasthan. We find further that such species possess normal or 'abnormal' type of sporocarps and the range of this abnormality also varies in these plants.

It is not our purpose for the present to discuss the significance of these observations, which seem to us of very great importance in the genus *Marsilea*, but only to put on record the nature of the material so far available in this country and stimulate, if possible, the interest for further collections of this interesting water fern. One of us had suggested 'to examine in detail all the herbarium sheets of at least the Indian species at the earliest opportunity' (3, p. 955, 1955) This has now been possible thanks to the kind cooperation of the authorities of the herbaria in Calcutta, Dehra Dun, and Bombay.

The present position of the collections at these three places and in the department of Botany, Jaswant College, Jodhpur, is as follows:

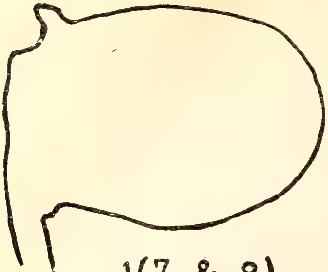
S.N.	Name of Herbarium.	No. of sheets Examined.	No. of spp. present.	No. of sheets redetermined.	Remarks.
1.	Ind. Bot. Gardens, Calcutta.	19	3	7	
2.	St. Xavier's College, Bombay.	32	3	10	
3.	Forest Research Institute, Dehra Dun.	31	6, 2 spp. foreign.	5	6 Sheets foreign.
4.	Jaswant College, Jodhpur.	45	9	2	

It will be noticed that, in spite of the fact that the genus *Marsilea* is very widely distributed in India from north to south and from east to west and that there are nearly ten species present in the Indian flora, our collections are very poor. Of course, by examination of the above collections, we have by no means exhausted the possibility of discovering valuable material at other places of learning, particularly the south Indian Universities or institutions, because it is from S. India and the Nilgiris that some rare species were recorded by Braun in the last century (2). Our collection at Jodhpur is by far the best at present. The table of characters given below indicates the number and nature of the species present in some of the important herbaria in India and it is hardly necessary to add that further collections, particularly from south India, will be forthcoming and must be made before any adequate conclusions can be drawn on the exact nature of the material in this vast country.

This examination, though brief, has enlarged the boundaries of *M. aegyptiaca* in India because we now record for the first time the occurrence of this species at Varavandi in Ahmednagar district and at Cuttack in Orissa; Jodhpur, Jaisalmer, Bhilwara, and perhaps Ajmer in Rajasthan being already known to possess this species (6). It has also confirmed our observation about a series of well-defined variations, particularly in the anatomy of the sporocarps, thus giving us a glimpse as if into the possible existence of many ecotypes in the genus. Not only the internal structure of the sporocarps, making them normal or 'abnormal', but even their external features vary greatly in the same species. This is particularly so in a species with wide distribution as if it is in a state of dynamic flux.

One of us who recently examined a large collection of *Marsilea* from the University of California, thanks to the kindness and generosity of Prof. H. L. Mason, Director of the Herbarium, had noticed that *M. vestita*, which too has a very wide distribution in America just as *M. minuta* has in India, also possesses both normal and 'abnormal' type of sporocarps (5). From a series of diagrams (text figs. 1–48) drawn from the herbarium sheets now examined you will notice the range of variation in the size and shape of the sporocarps including the horns of a single species *M. minuta* in India. This range of variations is not confined to their external appearance only but affects the internal organisation too. What process is at work it is not the intention of the authors to discuss in the present paper. It may not be out of place, however, to mention that some of the most important characters that are of value in the identification of the species of *Marsilea* are firstly the attachment of the pedicel to petiole together with the grouping of the sporocarps, secondly the shape and size of the sporocarps including the number and nature of horns, thirdly the soral number inside the sporocarps, and finally the abnormal or normal nature of the sporocarps, depending upon the structure of the megasporangia and microsporangia and megaspores and microspores.

The shape and size of the vegetative organs together with the structure of the hairs covering these and the sporocarps as well as the epidermal characters of the leaves may provide characters of subsidiary importance to a systematist but not until their determination and range of variability have been studied under ideal experimental conditions; for the genus *Marsilea* is well known for its morphological plasticity in its vegetative organs.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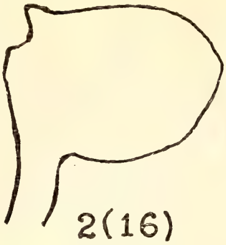
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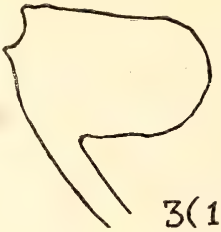
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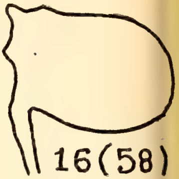
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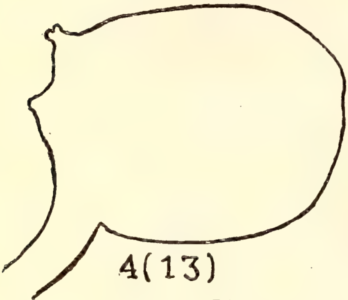
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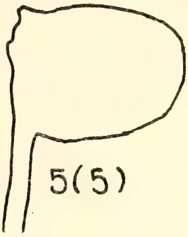
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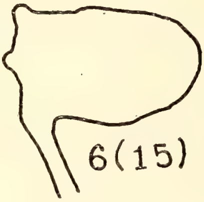
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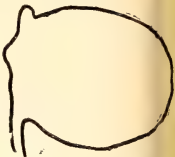
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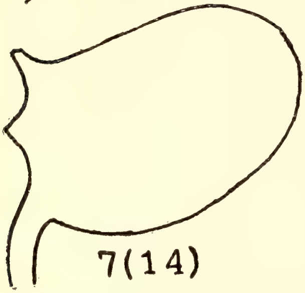
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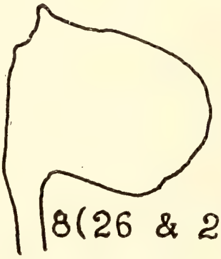
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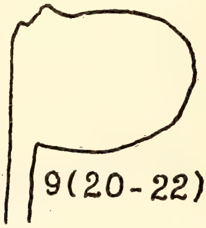
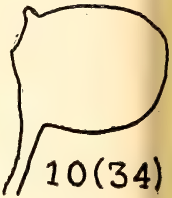

9(20-22)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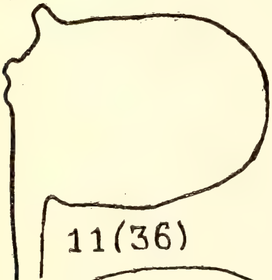
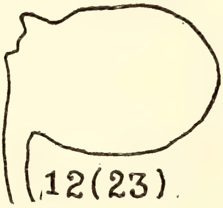

11(36)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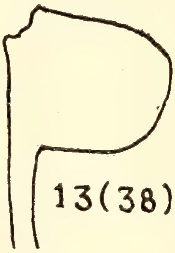
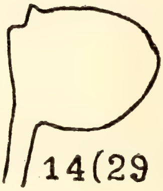
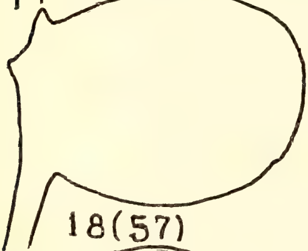

13(38)


14(29 & 30)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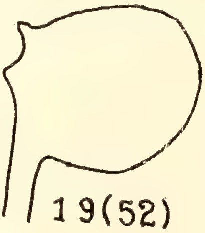
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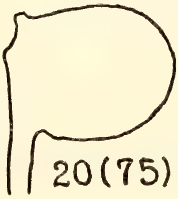
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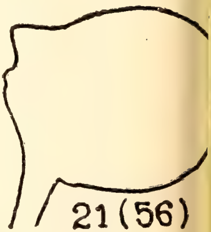
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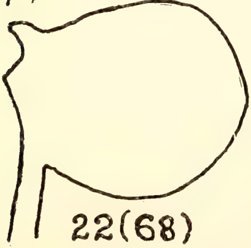
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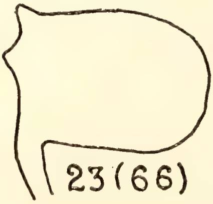
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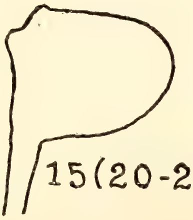
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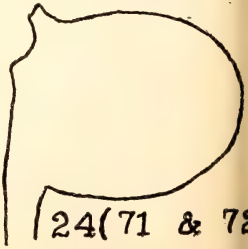
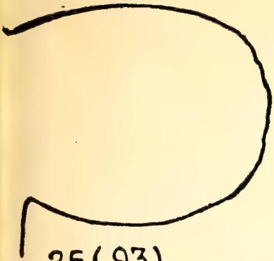

24(71 & 72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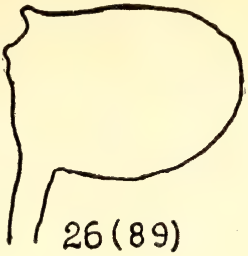
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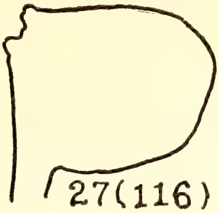
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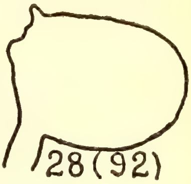
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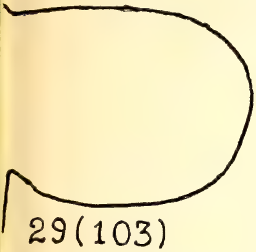
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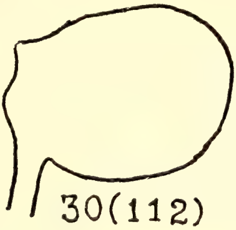
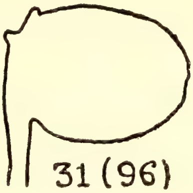

30(112)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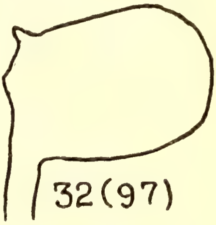
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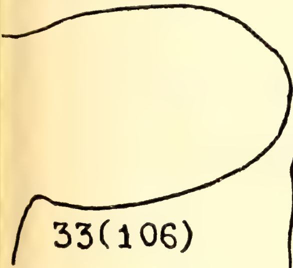
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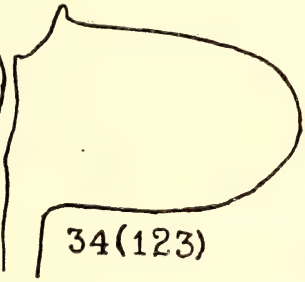
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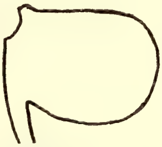
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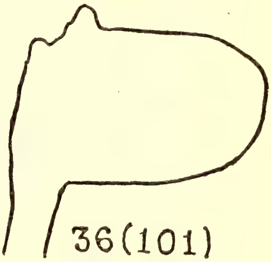
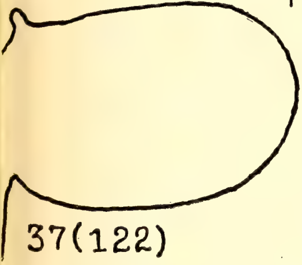
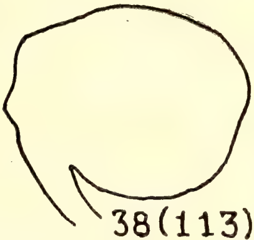

36(101)


37(122)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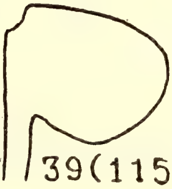
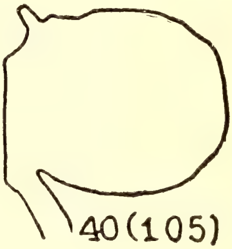
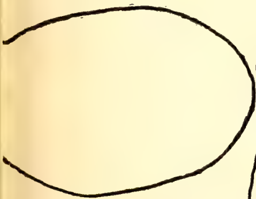

39(115)


40(105)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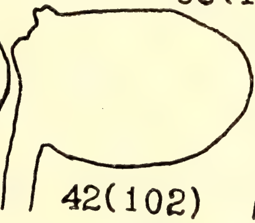
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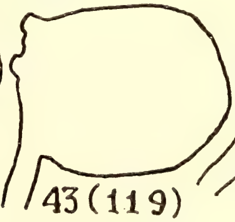
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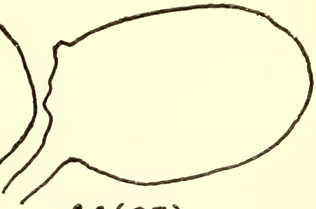
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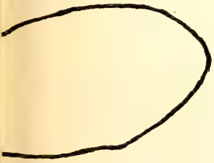
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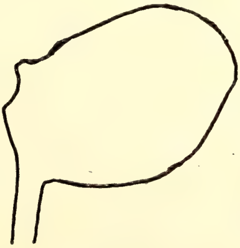
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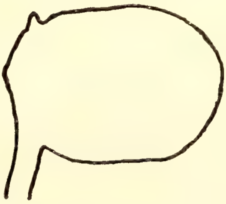
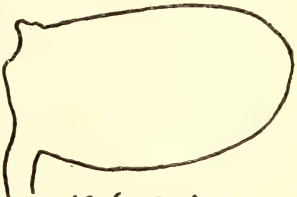

47(94)


48(121)

SUMMARY

Eighty-two herbarium sheets of the genus *Marsilea* from three important herbaria in India, besides our own collections at Jodhpur, have been examined and their identification either confirmed or revised, so as to indicate roughly the present position of our knowledge of the Indian collections. A great range of variability in the size, shape, and structure of the sporocarps in a species like *M. minuta* having wide distribution have been noted.

ACKNOWLEDGMENT

The authors wish to express their gratitude to Fr. H. Santapau, Shri M. B. Raizada, and Dr. D. Chatterji for their kindness and generosity in lending the material for examination by the authors from their herbaria at St. Xavier's College, Bombay, F. R. I., Dehra Dun, and Indian Botanical Garden, Calcutta, respectively. We are much indebted to Mr. A. H. G. Alston of the British Museum, London, for photographs of *M. aegyptiaca*, *M. quadrifolia*, *M. brachypus*, *M. brachycarpa*, *M. gracilenta*, and *M. coromandelica*. To Dr. Meyr of the Botanischer Garten und Museum, Dahlem, Berlin, we are grateful for a small quantity of material and photographs of the type specimens from Bräun's original collections of the Indian species, namely *M. brachypus*, *M. brachycarpa*, *M. gracilenta*, and *M. coromandelica*.

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2. Bräun, A. (1870) : Revision of the genus *Marsilea*. Monats. Kon. Akad. Wiss. Berl. S. 653 ff.

3. Gupta, K. M. (1955) : On the occurrence of *M. aegyptiaca* Willd. in Jodhpur, Rajasthan (India). *JBNHS* **52** : 954-956.

4. Gupta, K. M. (1955) : A new species of *Marsilea*, *M. ballardii*, sp. nov. Gupta from Ajmer, India. *JBNHS*, **53** : 289-292.

5. Gupta, K. M. (1956) : Some American species of *Marsilea* with special reference to their epidermal and soral characters. (In press).

6. Gupta, K. M. and Bhardwaja, T. N. (1956) : Indian Marsileas : their Morphology and Systematics—1. *M. aegyptiaca* Willd. with remarks on the present systematic position of Indian species. *JBNHS*, **53** : 423-444.

EXPLANATION OF TEXT FIGS. 1-48.

Figs. 1-7 : Herbarium, Indian Botanical Gardens, Calcutta.
Figs. 8-15 : Blatter Herbarium, St. Xavier's College, Bombay.
Figs 16-24 : Herbarium F. R. I., Dehra Dun.
Figs. 25-48 : Herbarium, Botany Department, Jaswant College, Jodhpur.

N.B. The numbers in the bracket indicate the serial number of the table, i.e the herbarium sheet from which the outline of the sporocarp has been drawn. All figures are magnified *ca.* × 9.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*

A. Indian Botanic Garden, Calcutta

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
*1.	*Marsilea minuta* ...	Sheet No. 127; Banda, N.W.F.; 8th March 1901; Mrs. A. S. Bell.	Attachment *M. minuta* type.
2.	*M. quadrifoliata* ...	Jalpaiguri; 22nd February 1911; Ribu and Rhomoo	absent
3.	*M. quadrifoliata* ...	Sheet No. 287; Jule Lake, Shan States; 22nd February 1917.	absent
4.	*M. quadrifoliata* ...	Sheet No. 774; Pegu; Youmah; S. Kurz.	absent
*5.	*M. minuta* ...	Burmah; D. Praudii.	Sporocarps bordered; horns two, upper longer and blunt, lower obscure; normal
6.	*M. quadrifoliata* ...	Sheet No. 106; Punjab; 1866. Clark.	absent
7. 8.	*M. minuta* ...	Peshawar; June 1892; Gen. M. H. Collet.	Horns two, upper longer and pointed lower obscure; abnormal.
9.	*Marsilea* sp. ...	Hussain Hazara.	absent
10.	*Marsilea* sp. ...	Sheet No. 558; Kohat.	absent
11.	*M. quadrifoliata* ...	Sheet No. 187; Chhota Nagpur; 21st January 1878; Dr. J. J. Wood.	absent

* Species redetermined by the present authors.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
12.	*M. minuta* var. *major*	Sheet No. 685; Singhbhum; January 1903; H. H. Haines.	absent
*13.	*M. minuta*	Sheet No. 22942; Bhira, Kheri Dist., Oudh; 14th April 1898; M. Inayat.	Pedicels obscurely connate and basal; horns two, almost similar not prominent; soral no. 12; abnormal.
*14.	*M. minuta*	Sheet No. 3680; Dharampuram, Coimbatore Dist.; 17th January 1914; C. E. C. Fischer.	Pedicels obscurely connate and basal; sporocarps bordered, distinctly ribbed; horns two, upper pointed and longer; normal.
*15.	*M. minuta*	Sheet No. 11399; Mysore; October 1909. A. Meeblod.	Pedicels free and basal; sporocarps distinctly bordered and ribbed; horns two, almost similar, not prominent.
*16.	*M. minuta*	Sheet No. 133686; Gullenj, Ganjam Dist., Madras; January 1884.	Pedicels free and basal; horns absent or obscure; normal.
17.	*Marsilea* sp.	Sheet No. 409; Sagaing, Upper Burma; 25th March 1893; Dr. King's Collector.	absent
*18.	*M. minuta*	Sheet No. 390; Bilin, Upper Burma; 18th March 1893; Dr. King's Collector.	Pedicels free and basal; sporocarps ribbed and bordered; horns two, similar, not prominent; normal.
19.	*M. aegyptiaca*	Sheet No. $\frac{\text{M} - \text{1DT}}{\text{Ju} - 55}$, Jodhpur.	Pedicels basal, solitary sporocarps square, grooved and depressed; upper blunt horn present; soral no. 4-6; normal.

B. Blatter Herbarium, St. Xavier's College, Bombay

20. 21. 22.	*M. minuta*	Sheets Nos. 469, 470, 93706 ; Khandala pool (near station), Khandala ; 27th May 1942 ; H. Santapau.	Attachment *M. minuta* type. Horns two almost similar ; soral no. 8-10 ; normal.
*23.	*M. minuta*	Sheet No. 8257 ; Paradise Flat, Purandhar ; 26th December 1945 , H. Santapau.	Pedicels basal ; horns two, upper, longer and pointed ; soral no. 11-12 ; normal.
*24. 25.	*M. minuta*	Sheets Nos. 400-45, 400-46 ; Condita, Salsette Island ; 18th January 1942 ; H. Santapau.	Horns two, almost similar.
26. 27.	*M. minuta*	Sheets Nos. 16994 and 16995; Unai, near Rest House, Dangs ; 30th October 1953 ; H. Santapau.	Pedicels connate and basal ; horns two, upper longer and pointed ; soral no. 6-9 ; normal.
28.	*M. quadrifolia*	Sheet No. 8117 ; Khandala Talao and neighbourhood ; 27th November 1945 ; H. Santapau.	absent
*29. 30.	*M. minuta*	Sheets Nos. 4159 & 4160 ; Khandala Talao and neighbourhood ; 2nd May 1944 ; H. Santapau.	Pedicels slightly connate and basal ; horns two, almost similar ; soral no. 8 ; normal.
31. 32. 33.	*Marsilea* sp.	Sheets Nos. 400-55, 400-56, 400-57 ; Khandala railway station ; 21st April 1942 ; H. Santapau.	absent
*34.	*M. minuta*	Sheet No. 2364 ; Drying edges of a tank, Mugad, Dharwar Dist. ; January 1917.	Pedicels slightly connate and basal ; horns two, almost similar ; normal.
*35.	*M. aegyptiaca*	Sheet No. 7358 ; Varavandi, Ahmednagar Dist. ; 1920 ; Nana.	Pedicels basal, solitary ; sporocarps square, grooved and depressed ; upper blunt horn present ; soral no. 4-6 ; normal.
*36.	*M. minuta*	Near Bandra Station, Bandra ; May 1919 ; B. N. Vakil.	Pedicels free and basal ; horns two, upper slightly longer ; normal.

* Species redetermined by the present authors.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
12.	*M. minuta* var. *major*	Sheet No. 685; Singhbhum; January 1903; H. H. Haines.	absent
*13.	*M. minuta*	Sheet No. 22942; Bhira, Kheri Dist., Oudh; 14th April 1898; M. Inayat.	Pedicels obscurely connate and basal; horns two, almost similar not prominent; soral no. 12; abnormal.
*14.	*M. minuta*	Sheet No. 3680; Dharampuram, Coimbatore Dist.; 17th January 1914; C. E. C. Fischer.	Pedicels obscurely connate and basal; sporocarps bordered, distinctly ribbed; horns two, upper pointed and longer; normal.
*15.	*M. minuta*	Sheet No. 11399; Mysore; October 1909. A. Meebold.	Pedicels free and basal; sporocarps distinctly bordered and ribbed; horns two, almost similar, not prominent.
*16.	*M. minuta*	Sheet No. 133686; Gullenj, Ganjam Dist., Madras; January 1884.	Pedicels free and basal; horns absent or obscure; normal.
17.	*Marsilea* sp.	Sheet No. 409; Sagaing, Upper Burma; 25th March 1893; Dr. King's Collector.	absent
*18.	*M. minuta*	Sheet No. 390; Bilin, Upper Burma; 18th March 1893; Dr. King's Collector.	Pedicels free and basal; sporocarps ribbed and bordered; horns two, similar, not prominent; normal.
19.	*M. aegyptiaca*	Sheet No. $\frac{M-1DT}{Ju-55}$, Jodhpur.	Pedicels basal, solitary sporocarps square, grooved and depressed; upper blunt horn present; soral no. 4-6; normal.
		B. Blatter Herbarium, St. Xavier's College, Bombay	
20. 21. 22.	*M. minuta*	Sheets Nos. 469, 470, 93706; Khandala pool (near station), Khandala; 27th May 1942; H. Santapau.	Attachment *M. minuta* type. Horns two almost similar; soral no. 8-10; normal.
*23.	*M. minuta*	Sheet No. 8257; Paradise Flat, Purandhar; 26th December 1945, H. Santapau.	Pedicels basal; horns two, upper, longer and pointed; soral no. 11-12; normal.
*24. 25.	*M. minuta*	Sheets Nos. 400-45, 400-46; Condita, Salsette Island; 18th January 1942; H. Santapau.	Horns two, almost similar.
26. 27.	*M. minuta*	Sheets Nos. 16994 and 16995; Unai, near Rest House, Dangs; 30th October 1953; H. Santapau.	Pedicels connate and basal; horns two, upper longer and pointed; soral no. 6-9; normal.
28.	*M. quadrifolia*	Sheet No. 8117; Khandala Talao and neighbourhood; 27th November 1945; H. Santapau.	absent
*29. 30.	*M. minuta*	Sheets Nos. 4159 & 4160; Khandala Talao and neighbourhood; 2nd May 1944; H. Santapau.	Pedicels slightly connate and basal; horns two, almost similar; soral no. 8; normal.
31. 32. 33.	*Marsilea* sp.	Sheets Nos. 400-55, 400-56, 400-57; Khandala railway station; 21st April 1942; H. Santapau.	absent
*34.	*M. minuta*	Sheet No. 2364; Drying edges of a tank, Mugad, Dharwar Dist.; January 1917.	Pedicels slightly connate and basal; horns two, almost similar; normal.
*35.	*M. aegyptiaca*	Sheet No. 7358; Varavandi, Ahmednagar Dist.; 1920; Nana.	Pedicels basal, solitary; sporocarps square, grooved and depressed; upper blunt horn present; soral no. 4–6; normal.
*36.	*M. minuta*	Near Bandra Station, Bandra; May 1919; B. N. Vakil.	Pedicels free and basal; horns two, upper slightly longer; normal.

* Species redetermined by the present authors.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
37.	*Marsilea* sp.	Water-logged ricefields at Danda; September 1919; B. N. Vakil.	absent
*38.	*Marsilea minuta*	Sheet No. 28538; Khandala; May 1919.	Pedicels free and basal; horns two, almost similar; normal.
39.	*M. minuta*	Growing along the border of a tank at Bandra.	absent
40.	*M. minuta*	Sheet No. 3353; Khandala Talao, Khandala; 21st December 1943; H. Santapau.	Sporocarps scarce.
41. 42.	*Marsilea* sp.	Sheets Nos. 467 and 472; Khandala station, Khandala; 27th May 1942; H. Santapau.	absent
43.	*Marsilea* sp.	Sheet No. 468; Khandala station, Khandala; 27th May 1942; H. Santapau.	absent
44.	*Marsilea* sp.	Sheet No. 400-24; Mulgaon, Salsette Islands; 31st August 1942; H. Santapau.	absent
45.	*M. quadrifolia*	Sheet No. 16759; Mithapur, Saurashtra; 15th October 1953; H. Santapau.	absent
46.	*M. quadrifolia*	Sheet No. 16862; beyond station, Rajkot, Saurashtra; 20th October 1953.	absent
47.	*M. aegyptiaca*	Botanical Gardens, Jaswant College, Jodhpur; April 1956.	Pedicels basal, solitary; sporocarps square, grooved and depressed; upper blunt horn present; soral no. 4-6; normal.

48.	*M. ballardii* ...	Botanical Gardens, Jaswant College, Jodhpur; April 1956.	Pedicels free and basal; only upper pointed horn, lower absent; soral no. 9; abnormal.
*49.	*M. minuta* ...	Ajmer; 20th November 1954; T. N. Bhardwaja.	Pedicels free and basal; upper horn inconspicuous, lower obscure; soral no. 11, normal.
*50.	*M. minuta* ...	Udaipur; February 1956; T. N. Bhardwaja.	Pedicels basal and free; horns two, upper longer and pointed, lower inconspicuous; soral no. *ca.* 10; normal.
51.	*M. minuta* ...	Najafgarh Road, Delhi; 4th February 1956; T. N. Bhardwaja.	Pedicels free and basal; horns two upper inconspicuous, lower obscure; soral no. 12; normal.

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*52.	*M. minuta* ...	Sheet No. 2613; Dalakudar, Gangpur State, Orissa; 23rd February 1946; H. F. Mooney.	Pedicels free and basal; horns two, upper pointed; soral no. 7–12; abnormal.
53.	*M. minuta* ...	Sheet No. 466; Thal to Shalizan, **Afghanistan**; 24th August 1888; J. E. T. Aitchison.	absent
54.	*M. minuta* ...	Sheet No. 6797; 4th November 1887; M. Sikandya Rao.	Pedicels free and basal; horns two, almost similar, blunt; normal.
55.	*M. minuta* ...	Sheet No. 15054; Jaunsar, U.P.; 1894; J. S. Gamble.	absent
56.	*M. minuta* ...	Sheet No. 228; Multan; A. V. Mours and others.	Pedicels free and basal; upper horn present, lower horn obscure; normal.
**57.	*M. minuta* ...	Sheet No. 22942; Bhira Kheri district, Oudh; 14th April 1898; M. Inayat.	Pedicels obscurely connate and basal; horns two, almost similar; not prominent; soral no. 12; abnormal.

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* Species redetermined by the present authors.

** Same as No. 13 of Calcutta Herbarium.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
37.	*Marsilea* sp. ...	Water-logged ricefields at Danda; September 1919; B. N. Vakil.	absent
*38.	*Marsilea minuta* ...	Sheet No. 28538; Khandala; May 1919.	Pedicels free and basal; horns two, almost similar; normal.
39.	*M. minuta* ...	Growing along the border of a tank at Bandra.	absent
40.	*M. minuta* ...	Sheet No. 3353; Khandala Talao, Khandala; 21st December 1943; H. Santapau.	Sporocarps scarce.
41. 42.	*Marsilea* sp. ...	Sheets Nos. 467 and 472; Khandala station, Khandala; 27th May 1942; H. Santapau.	absent
43.	*Marsilea* sp. ...	Sheet No. 468; Khandala station, Khandala; 27th May 1942; H. Santapau.	absent
44.	*Marsilea* sp. ...	Sheet No. 400–24; Mulgaon, Salsette Islands; 31st August 1912; H. Santapau.	absent
45.	*M. quadrifolia* ...	Sheet No. 16759; Mithapur, Saurashtra; 15th October 1953; H. Santapau.	absent
46.	*M. quadrifolia* ...	Sheet No. 16862; beyond station, Rajkot, Saurashtra; 20th October 1953.	absent
47.	*M. aegyptiaca* ...	Botanical Gardens, Jaswant College, Jodhpur; April 1956.	Pedicels basal, solitary; sporocarps square, grooved and depressed; upper blunt horn present; soral no. 4–6; normal.
48.	*M. ballardii* ...	Botanical Gardens, Jaswant College, Jodhpur; April 1956.	Pedicels free and basal; only upper pointed horn, lower absent; soral no. 9; abnormal.
*49.	*M. minuta* ...	Ajmer; 20th November 1954; T. N. Bhardwaja.	Pedicels free and basal; upper horn inconspicuous, lower obscure; soral no. 11, normal.
*50.	*M. minuta* ...	Udaipur; February 1956; T. N. Bhardwaja.	Pedicels basal and free; horns two, upper longer and pointed, lower inconspicuous; soral no. *ca.* 10; normal.
51.	*M. minuta* ...	Najafgarh Road, Delhi; 4th February 1956; T. N. Bhardwaja.	Pedicels free and basal; horns two upper inconspicuous, lower obscure; soral no. 12; normal.
		C. F. R. I. Herbarium, Dehra Dun	
*52.	*M. minuta* ...	Sheet No. 2613; Dalakudar, Gangpur State, Orissa; 23rd February 1946; H. F. Mooney.	Pedicels free and basal; horns two, upper pointed; soral no. 7–12; abnormal.
53.	*M. minuta* ...	Sheet No. 466; Thal to Shalizan, Afghanistan; 24th August 1888; J. E. T. Aitchison.	absent
54.	*M. minuta* ...	Sheet No. 6797; 4th November 1887; M. Sikandya Rao.	Pedicels free and basal; horns two, almost similar, blunt; normal.
55.	*M. minuta* ...	Sheet No. 15054; Jaunsar, U.P.; 1894; J. S. Gamble.	absent
56.	*M. minuta* ...	Sheet No. 228; Multan; A. V. Mours and others.	Pedicels free and basal; upper horn present, lower horn obscure; normal.
**57.	*M. minuta* ...	Sheet No. 22942; Bhira Kheri district, Oudh; 14th April 1898; M. Inayat.	Pedicels obscurely connate and basal; horns two, almost similar; not prominent; soral no. 12; abnormal.

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* Species redetermined by the present authors.
** Same as No. 13 of Calcutta Herbarium.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
58.	*M. minuta* var. *erosa*	Sheet No. 6606; Kounb, NW. India; 14th February 1923.	Pedicels free and basal; horns two, almost similar, upper slightly pointed; soral no. *ca.* 7; normal.
59.	*M. quadrifoliata*	Sheet No. 18729; Palampur; 26th September 1896; G. A. Gammie.	absent
60.	*M. minuta*	Sheet No. 5254; Jan, Aligarh district; 22nd December 1885; J. F. Duthie.	Pedicels free and basal; upper horn slightly pointed, lower obscure or absent; normal.
61.	*M. minuta*	Sheet No. 5254 (*a*); Jessakhera to Bhim, Marwar, Rajasthan; 6th January 1886; J. F. Duthie.	absent
62.	*M. minuta* var. *erosa*	Sheet No. 5255; Jan and Pilkatra; 22nd December 1885; J. F. Duthie.	absent
63.	*M. minuta*	Sheet No. 6—2,000; W. Dun near Khakrani; March 1879; J. F. Duthie.	absent
64.	*M. quadrifolia*	Garta Hills beyond Mussoorie; October 1879 J. F Duthie.	absent
65.	*M. minuta*	Doulpore; July 1942.	Pedicels free and basal; horns two, upper pointed upwards, lower obscure; soral no. 9; normal.
66.	*M. minuta* var. *erosa*	Sheet No. 6606; Kounch, Bundelkhand; 2nd December 1886; J. F. Duthie.	Pedicels free and basal; horns two, upper longer and pointed; soral no. *ca.* 8; normal.
67.	*M. minuta*	Sheet No 1473; Rawalpindee; September 1870; J. E. T. Aitchison.	absent

*68.	*M. minuta* ...	Sheet No. 5255 (*a*) Baghpat, near Jamuna, Meerut Dist. ; 11th December 1885 ; J. F. Duthie.	Pedicels free and basal ; upper horn longer and lower obscure ; soral no. 11–12 ; abnormal.
*69.	*M. aegyptiaca* ...	Sheet No. 101800 ; Central Rice, Cuttack ; 5th February 1919 ; S. Y. Padmanabhan.	Pedicels basal, solitary ; sporocarps square, grooved, and depressed ; upper blunt horn present ; soral no. 4–6 ; normal.
70.	*M. aegyptiaca* ...	Sheet No. 1183 ; Bijolai and Lal Sagar ; Jodhpur ; March 1954 ; Dr. K. M. Gupta.	Pedicels basal, solitary ; sporocarps square, grooved and depressed, upper blunt horn present ; soral no. 4–6 ; normal.
71. 72.	*M. minuta* ...	Sheets Nos. 83996 and 83997 ; Roy. Bot. Gardens, Calcutta ; February 1910 ; M. B. Raizada.	Pedicels free and basal ; upper horn longer and pointed, lower obscure ; abnormal.
†73.	*M. minuta* ...	Sheet No. 93706 ; Khandala pool, near station, Khandala ; 27th May 1912 ; H. Santapau.	Attachment *M. minuta* type; horns two, almost similar ; soral no. 8–10 ; normal.
**74.	*M. minuta* ...	Sheet No. 91188 ; Condita, Salsette Island ; 1st January 1912 ; H. Santapau.	absent
*75.	*M. minuta* ...	Sheet No. 22912(*a*) ; Gorakhpur dist. 10th April 1898 ; C. N. Karouhh.	Pedicels free and basal ; horns two, not prominent, upper slightly longer ; normal.
*76.	*M. minuta* ...	Sheet No. 18569 ; Bandanchala, Godavari district ; January 1887 ; J. S. Gamble.	Pedicels free and basal ; sporocarps ribbed and bordered; horns two upper longer and pointed, lower blunt, normal.
77.	*M. vestita* ...	Sheet No. 3994 ; Moist soil, East of Boulder, Boulder Company, Colorado ; 14th September 1921 ; E. Bethal, F. S. Willey, I. W. Clokey.	Pedicels basal, solitary; horns two, lower prominent ; soral no. *ca*. 15.
78.	*M. minuta* ...	Sheet No. 5244 ; Ex. heb. G. Bonate ; New Caledonia.	absent

* Species redetermined by the present authors.
† Same as Nos. 20, 21, 22. of Blatter Herbarium, Bombay.
** Same as Nos. 24 and 25 of Blatter Herbarium, Bombay.

DETAILS OF THE COLLECTIONS OF MARSILEA IN SOME INDIAN HERBARIA—(Contd.)

1	2	3	4
S. N.	Name of species	Herbarium details	Characters of the sporocarps
58.	*M. minuta* var. *erosa* ...	Sheet No. 6606; Kounch, NW. India; 14th February 1923.	Pedicels free and basal; horns two, almost similar, upper slightly pointed; soral no. *ca.* 7; normal.
59.	*M. quadrifoliata* ...	Sheet No. 18729; Palampur; 26th September 1896; G. A. Gammie.	absent
60.	*M. minuta* ...	Sheet No. 5254, Jan, Aligarh district; 22nd December 1885; J. F. Duthie.	Pedicels free and basal; upper horn slightly pointed, lower obscure or absent; normal.
61.	*M. minuta* ...	Sheet No. 5254 (*a*); Jessakhera to Bhim, Marwar, Rajasthan; 6th January 1886; J. F. Duthie.	absent
62.	*M. minuta* var. *erosa* ...	Sheet No. 5255; Jan and Pilkatra; 22nd December 1885; J. F. Duthie.	absent
63.	*M. minuta* ...	Sheet No. 6—2,000; W. Dun near Khakrani; March 1879; J. F. Duthie.	absent
64.	*M. quadrifolia* ...	Garta Hills beyond Mussoorie; October 1879 J. F Duthie.	absent
65.	*M. minuta* ...	Doulpore, July 1942.	Pedicels free and basal; horns two, upper pointed upwards, lower obscure; soral no. 9; normal.
66.	*M. minuta* var. *erosa* ...	Sheet No. 6606; Kounch, Bundelkhand; 2nd December 1886; J. F. Duthie.	Pedicels free and basal; horns two, upper longer and pointed; soral no. *ca.* 8; normal.
67.	*M. minuta* ...	Sheet No 1473; Rawalpindee; September 1870; J. E. T. Aitchison.	absent
*68.	*M. minuta* ...	Sheet No. 5255 (*a*) Baghpat, near Jamuna, Meerut Dist.; 11th December 1885; J. F. Duthie.	Pedicels free and basal; upper horn longer and lower obscure; soral no. 11–12; abnormal
*69.	*M. aegyptiaca* ...	Sheet No. 101800; Central Rice, Cuttack; 5th February 1949; S. Y. Padmanabhan.	Pedicels basal, solitary; sporocarps square, grooved, and depressed; upper blunt horn present; soral no. 4–6; normal.
70.	*M. aegyptiaca* ...	Sheet No. 1183; Bijolai and Lal Sagar; Jodhpur; March 1954; Dr. K. M. Gupta.	Pedicels basal, solitary; sporocarps square, grooved and depressed, upper blunt horn present; soral no. 4–6; normal.
71. 72.	*M. minuta* ...	Sheets Nos. 83995 and 83997; Roy. Bot. Gardens, Calcutta; February 1940; M. B. Raizada.	Pedicels free and basal; upper horn longer and pointed, lower obscure; abnormal.
†73.	*M. minuta* ...	Sheet No. 93706; Khandala pool, near station, Khandala; 27th May 1912; H. Santapau.	Attachment *M. minuta* type; horns two, almost similar; soral no. 8–10; normal.
**74.	*M. minuta* ...	Sheet No. 91188; Condita, Salsette Island; 1st January 1912; H. Santapau.	absent
*75.	*M. minuta* ...	Sheet No. 22912(*a*); Gorakhpur dist. 10th April 1898; C. N. Karoubh.	Pedicels free and basal; horns two, not prominent, upper slightly longer; normal.
*76.	*M. minuta* ...	Sheet No. 18569; Bandanchala, Godavari district; January 1887; J. S. Gamble.	Pedicels free and basal; sporocarps ribbed and bordered; horns two upper longer and pointed, lower blunt, normal.
77.	*M. vestita* ...	Sheet No. 3994; Moist soil, East of Boulder, Boulder Company, Colorado; 14th September 1921; E. Bethal, F. S. Willey, I. W. Clokey.	Pedicels basal, solitary; horns two, lower prominent; soral no. *ca.* 15.
78.	*M. minuta* ...	Sheet No. 5244; Ex. heb. G. Bonate; New Caledonia.	absent

* Species redetermined by the present authors.
† Same as Nos. 20, 21, 22. of Blatter Herbarium, Bombay.
** Same as Nos. 24 and 25 of Blatter Herbarium, Bombay.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
79.	*M. quadrifolia* ...	Sheet No. 1504 ; Central Hungaria.	Pedicels adnate and connate for about half their length ; horns 2 almost similar ; soral no. 16–20.
80.	*M. quadrifolia* ...	Sheet No. 1179 ; August–September 1867.	Pedicels adnate and connate for about half their length ; horns two, almost similar ; soral no. 16-20.
81.	*M. quadrifolia* ...	——	absent
82.	*M. strigosa* ...	America, Volgamerid, Zenith.	Pedicels basal; horns two, obscure; soral no. 8–10.
		D. Herbarium, Botany Department, Jaswant College, Jodhpur	
83.	*M. aegyptiaca* ...	Sheet No. $\frac{1M-1OR}{JU-54}$; Bijolai and Lalsagar, Jodhpur; March 1954 ; K. M. Gupta.	Pedicels basal, solitary ; sporocarps square, grooved, and depressed ; upper blunt horn present ; soral no. 4–6 ; normal.
84.	*M. poonensis* ...	$\frac{2M-1OR}{PO-54}$; Poona ; 20th October 1954 ; G G. Kolhatkar.	Pedicels slightly connate and basal; sporocarps distinctly ribbed ; horns two, upper prominent, lower obscure ; soral no. 10–14 ; normal.
*85.	*M. minuta* ...	$\frac{3M-1OR}{AJ-54}$; Gugra, Ajmer; 20th November 1954 ; T. N. Bhardwaja.	Pedicels free and basal ; upper horn inconspicuous, lower obscure ; soral no. 11 ; normal.

86.	*M. ballardii* ...	$\frac{4M - 2OR}{AJ - 54}$; Gugra, Ajmer; 20th November 1954; T. N. Bhardwaja.	Pedicels free and basal; only pper upointed horn, lower absent; soral no. 9; abnormal.
87.	*M. aegyptiaca* ...	$\frac{5M - 1OR}{E - 54}$; Lower Egypt; 16th August 1954; A. H. Montasir.	absent
88.	*M. minuta* ...	$\frac{6M - 1OR}{D - 54}$; Dharwar; 14th December 1954; M. K. Chikapalapurm, and others.	Pedicels free and basal; horns two, upper longer and pointed upwards, lower obscure; soral no. 10; abnormal.
*89.	*M. minuta* ...	$\frac{7M - 1OR}{PR - 53}$; Shekhar Bazar, 24 Parganas; 16th February 1953; P. Pal.	Pedicels free and basal; sporocarps ribbed and bordered; horns two, upper longer and pointed, lower obscure; perhaps abnormal.
*90.	*M. quadrifolia* ...	$\frac{8M - 1OR}{KA - 54}$; Srinagar, Kashmir; September 1954; K. M. Vaid.	Pedicels adnate and connate for about half their length; horns two, almost similar; soral no. 16–20; normal.
91.	*M. minuta* ...	$\frac{9M - 1OR}{Ni - 55}$; Nipania, Santhal Parganas; 3rd January 1955; K. M. Gupta and Party.	Pedicels free and basal; sporocarps ribbed and bordered; horns two, upper longer and blunt, lower obscure; soral no. 11; abnormal.
*92.	*M. minuta* ...	$\frac{10M - 1OR}{U - 55}$; Udaipur; 30th January 1955; K. M. Gupta.	Pedicels basal and free; horns two, upper longer and pointed, lower inconspicuous; soral no. *ca.* 10; normal.
93.	*M. minuta* ...	$\frac{11M - 1OR}{AL - 55}$; Silisher, Alwar; February 1955; K. M. Gupta.	Pedicels free and basal; horns two, almost similar, inconspicuous; soral no. 14; abnormal.

* Species redetermined by the present authors

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
79.	*M. quadrifolia* ...	Sheet No. 1504 ; Central Hungaria.	Pedicels adnate and connate for about half their length ; horns 2 almost similar ; soral no. 16–20.
80.	*M. quadrifolia* ...	Sheet No. 1179 ; August–September 1867 .	Pedicels adnate and connate for about half their length ; horns two, almost similar ; soral no. 16–20.
81.	*M. quadrifolia* ...	——	absent
82.	*M. strigosa* ...	America, Volgamerid, Zenith.	Pedicels basal ; horns two, obscure ; soral no. 8–10.
	D. Herbarium, Botany Department, Jaswant College, Jodhpur		
83.	*M. aegyptiaca* ...	Sheet No. $\frac{\text{1M—1OR}}{\text{JU—54}}$; Bijolai and Lalsagar, Jodhpur; March 1954 ; K. M. Gupta.	Pedicels basal, solitary ; sporocarps square, grooved, and depressed ; upper blunt horn present ; soral no. 4–6 ; normal.
84.	*M. poonensis* ...	$\frac{\text{2M — 1OR}}{\text{PO — 54}}$; Poona ; 20th October 1954 ; G G. Kolhatkar.	Pedicels slightly connate and basal ; sporocarps distinctly ribbed ; horns two, upper prominent, lower obscure ; soral no. 10–14 ; normal.
*85.	*M. minuta* ...	$\frac{\text{3M — 1OR}}{\text{AJ — 54}}$; Gugra, Ajmer; 20th November 1954 ; T. N. Bhardwaja.	Pedicels free and basal ; upper horn inconspicuous, lower obscure ; soral no. 11 ; normal.
86.	*M. ballardii* ...	$\frac{\text{4M — 2OR}}{\text{AJ — 54}}$; Gugra, Ajmer ; 20th November 1954 ; T. N. Bhardwaja.	Pedicels free and basal ; only pper upointed horn, lower absent ; soral no. 9 ; abnormal.
87.	*M. aegyptiaca* ...	$\frac{\text{5M — 1OR}}{\text{E — 54}}$; Lower Egypt ; 16th August 1954 ; A. H. Montasir.	absent
88.	*M. minuta* ...	$\frac{\text{6M — 1OR}}{\text{D — 54}}$; Dharwar ; 14th December 1954 ; M. K. Chikapalapurm, and others.	Pedicels free and basal; horns two, upper longer and pointed upwards, lower obscure ; soral no. 10 ; abnormal.
*89.	*M. minuta* ...	$\frac{\text{7M — 1OR}}{\text{PR — 53}}$; Shekhar Bazar, 24 Parganas ; 16th February 1953 ; P. Pal.	Pedicels free and basal ; sporocarps ribbed and bordered ; horns two, upper longer and pointed, lower obscure ; perhaps abnormal.
*90.	*M. quadrifolia* ...	$\frac{\text{8M — 1OR}}{\text{KA — 54}}$; Srinagar, Kashmir ; September 1954 ; K. M. Vaid.	Pedicels adnate and connate for about half their length ; horns two, almost similar ; soral no. 16–20 ; normal.
91.	*M. minuta* ...	$\frac{\text{9M — 1OR}}{\text{Ni — 55}}$; Nipania, Santhal Parganas ; 3rd January 1955 ; K. M. Gupta and Party.	Pedicels free and basal ; sporocarps ribbed and bordered ; horns two, upper longer and blunt, lower obscure ; soral no. 11 ; abnormal.
*92.	*M. minuta* ...	$\frac{\text{10M — 1OR}}{\text{U — 55}}$; Udaipur ; 30th January 1955; K. M. Gupta.	Pedicels basal and free ; horns two, upper longer and pointed, lower inconspicuous; soral no. *ca.* 10 ; normal.
93.	*M. minuta* ...	$\frac{\text{11M — 1OR}}{\text{AL — 55}}$; Silisher, Alwar ; February 1955 ; K. M. Gupta.	Pedicels free and basal ; horns two, almost similar, inconspicuous ; soral no. 14 ; abnormal.

* Species redetermined by the present authors

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
94.	*M. minuta* ...	$\frac{\text{12M — 1OR}}{\text{LK — 55}}$; Chinhat, Lucknow; 8th February 1955; K. N. Kaul.	Pedicels free and basal; horns two, upper longer, lower inconspicuous; normal.
95.	*M. minuta* ...	$\frac{\text{13M — 1OR}}{\text{KO — 55}}$: Kota; 22nd February 1955; D. Gupta.	Pedicels free and basal; horns two, blunt and inconspicuous; soral no. 9; normal.
96.	*M. minuta* ...	$\frac{\text{14M — 1OR}}{\text{BH — 55}}$; Bharatpur; 22nd February 1955; K. M. Gupta.	Pedicels free and basal; horns two, almost similar and inconspicuous; soral no. 8–10; normal.
97.	*M. minuta* ...	$\frac{\text{15M — 1OR}}{\text{CH — 55}}$; Chandigarh; 22nd March 1955; P. C. Joshi.	Pedicel free and basal; sporocarps ribbed and bordered, horns two, upper longer and pointed, lower obscure; soral no. 11; abnormal.
*98.	*M. aegyptiaca* ...	$\frac{\text{16M — 2OR}}{\text{E — 55}}$; Photograph only; 26th August 1945.	Pedicels basal, solitary; sporocarps square, grooved and depressed; upper blunt horn present.
*99.	*M. quadrifolia* ...	$\frac{\text{17M — 1OR}}{\text{KA — 55}}$; Photograph only; 26th August 1955.	Pedicels adnate and connate for about half their length; horns two, almost similar.
100.	*M. aegyptiaca* ...	$\frac{\text{18M — 1OR}}{\text{JL — 55}}$; Jaisalmer; 31st October 1955; H. S. Narayana and Party.	Pedicels basal; solitary; sporocarps square, grooved and depressed; upper blunt horn present: soral no. 4–6; normal.

101.	*M. minuta*	...	$\frac{\text{19M — 1OR}}{\text{MR — 55}}$; Guindy, Madras; October 1955; M. O. P. Iyengar.	Pedicels connate and obscurely adnate; sporocarps ribbed and bordered; horns two, almost similar, upper pointed upwards; soral no. 10; normal.
102.	*M. minuta*	...	$\frac{\text{20M — 1OR}}{\text{TP — 55}}$; Tin Pahar, Bihar, 26th October 1955; T. N. Bhardwaja.	Pedicels free and basal; horns two, upper longer and pointed, lower inconspicuous; soral no. 14; normal.
10	*M. minuta*	...	$\frac{\text{21M — 1OR}}{\text{AG — 55}}$; Agra; October 1955; K. M. Gupta and Party.	Pedicels free and basal; horns two, inconspicuous; soral no. 14-16; normal.
104.	*M. minuta*	...	$\frac{\text{22M — 2OR}}{\text{LK — 55}}$; Lucknow University; Lucknow; 4th November 1955; P. L. Mital.	Pedicels free and basal; horns two, upper pointed and longer; soral no. 14.
105.	*M. minuta*	...	$\frac{\text{23M — 1OR}}{\text{AM — 55}}$; Amritsar; December 1955, D. S. Loyal.	Pedicels free and basal; horns two, upper inconspicuous, lower obscure, soral no 14; abnormal.
106.	*M. minuta*	...	$\frac{\text{24M — 1OR}}{\text{MP — 55}}$; Nagpur; December 1955.	Pedicels free and basal; horns two, almost similar; soral no. 10-11; abnormal.
107.	*Marsilea* sp.	...	$\frac{\text{25M — 1OR}}{\text{AN — 55}}$; Annamalai University; T. C. N. Singh.	absent
**108.	*M. brachycharpa*	...	$\frac{\text{26M — 1OR}}{\text{PE — 56}}$; Pegu; Dr. D. Meyr, Berlin.	Pedicels connate and obscurely adnate; horns two blunt; almost similar; soral no. 6.
**109.	*M. brachypus*	...	$\frac{\text{27M — 1OR}}{\text{NG — 56}}$; Neilgherris; Dr. D. Meyr, Berlin.	Pedicels slightly connate and basal, sporocarps distinctly ribbed; horns two, upper prominent; soral no. 7.

* Photographs kindly supplied by Mr. A. H. G. Alston, Brit. Mus., London.
** Photographs and material kindly supplied from Bräun's original types by Dr. Meyr, Berlin.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1	2	3	4
S. N.	Name of species	Herbarium details	Characters of the sporocarps
94.	*M. minuta*	$\frac{12M - 1OR}{LK - 55}$; Chinhat, Lucknow; 8th February 1955; K. N. Kaul.	Pedicels free and basal; horns two, upper longer, lower inconspicuous; normal.
95.	*M. minuta*	$\frac{13M - 1OR}{KO - 55}$; Kota; 22nd February 1955; D. Gupta.	Pedicels free and basal; horns two, blunt and inconspicuous; soral no. 9; normal.
96.	*M. minuta*	$\frac{14M - 1OR}{BH - 55}$; Bharatpur; 22nd February 1955; K. M. Gupta.	Pedicels free and basal; horns two, almost similar and inconspicuous; soral no. 8–10; normal.
97.	*M. minuta*	$\frac{15M - 1OR}{CH - 55}$; Chandigarh; 22nd March 1955; P. C. Joshi.	Pedicel free and basal; sporocarps ribbed and bordered, horns two, upper longer and pointed, lower obscure; soral no. 11; abnormal.
*98.	*M. aegyptiaca*	$\frac{16M - 2OR}{E - 55}$; Photograph only; 26th August 1945.	Pedicels basal, solitary; sporocarps square, grooved and depressed; upper blunt horn present.
*99.	*M. quadrifolia*	$\frac{17M - 1OR}{KA - 55}$; Photograph only; 26th August 1955.	Pedicels adnate and connate for about half their length; horns two, almost similar.
100.	*M. aegyptiaca*	$\frac{18M - 1OR}{JL - 55}$; Jaisalmer; 31st October 1955; H. S. Narayana and Party.	Pedicels basal; solitary; sporocarps square, grooved and depressed; upper blunt horn present: soral no. 4–6; normal.
101.	*M. minuta*	$\frac{19M - 1OR}{MR - 55}$; Guindy, Madras; October 1955; M. O. P. Iyengar.	Pedicels connate and obscurely adnate; sporocarps ribbed and bordered; horns two, almost similar, upper pointed upwards; soral no. 10; normal.
102.	*M. minuta*	$\frac{20M - 1OR}{TP - 55}$; Tin Pahar, Bihar, 26th October 1955; T. N. Bhardwaja.	Pedicels free and basal; horns two, upper longer and pointed, lower inconspicuous; soral no. 14; normal.
10 .	*M. minuta*	$\frac{21M - 1OR}{AG - 55}$; Agra; October 1955; K. M. Gupta and Party.	Pedicels free and basal; horns two, inconspicuous; soral no. 14-16; normal.
104.	*M. minuta*	$\frac{22M - 2OR}{LK - 55}$; Lucknow University; Lucknow; 4th November 1955; P. L. Mital.	Pedicels free and basal; horns two, upper pointed and longer; soral no. 14.
105.	*M. minuta*	$\frac{23M - 1OR}{AM - 55}$; Amritsar; December 1955, D. S. Loyal.	Pedicels free and basal; horns two, upper inconspicuous, lower obscure, soral no 14; abnormal.
106.	*M. minuta*	$\frac{24M - 1OR}{MP - 55}$; Nagpur; December 1955.	Pedicels free and basal; horns two, almost similar; soral no. 10-11; abnormal.
107.	*Marsilea* sp.	$\frac{25M - 1OR}{AN - 55}$; Annamalai University; T. C. N. Singh.	absent
**108.	*M. brachycharpa*	$\frac{26M - 1OR}{PE - 56}$; Pegu; Dr. D. Meyr, Berlin.	Pedicels connate and obscurely adnate; horns two blunt; almost similar; soral no. 6.
**109.	*M. brachypus*	$\frac{27M - 1OR}{NG - 56}$; Neilgherris; Dr. D. Meyr, Berlin.	Pedicels slightly connate and basal, sporocarps distinctly ribbed; horns two, upper prominent; soral no. 7.

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DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
**110	*M. gracilenta* ...	$\frac{28M - 10R}{CN - 56}$; Concan; Dr. D. Meyr, Berlin.	Pedicels free and basal; horns two, upper blunt, lower obscure.
**111.	*M. coromandelica* ...	$\frac{29M - 10R}{CM - 56}$; India; Dr. D Meyr, Berlin.	Pedicels basal and solitary; horns two, almost similar and prominent.
112.	*M. minuta* ...	$\frac{30M - 10R}{DL - 56}$; Delhi; 2nd February 1956; T. N. Bhardwaja.	Pedicels free and basal; horns two, upper inconspicuous, lower obscure; soral no. 12; normal.
113.	*M. minuta* ...	$\frac{31M - 10R}{U - 56}$; College compound, Udaipur; February 1956; T. N. Bhardwaja.	Pedicels free and basal: horns absent; soral no. 10; normal.
114.	*M. minuta* ...	$\frac{32M - 30R}{U - 56}$; Aad river, Udaipur; February 1956, T. N. Bhardwaja.	Pedicels free and basal; horns two, upper pointed, lower obscure; soral no. 9; abnormal.
115.	*M. minuta* ...	$\frac{33M - 10R}{SD - 56}$; Sarwad; 8th March 1956; B. V. Ratnam.	Pedicels slightly connate and obscurely adnate; horns two, inconspicuous, almost similar; soral no. 9; normal.
116.	*M. minuta* ...	$\frac{34M - 10R}{T - 56}$; Trichinopoly; 5th March 1956; Miss M. Jaya Marie.	Pedicels slightly connate and basal; sporocarps ribbed and bordered; horns two, upper pointed, lower obscure; soral no. 12; normal.
117.	*M. minuta* ...	$\frac{35M - 20R}{KO - 56}$; Dadabari, Kota; 20th June, 1956; V. K. Saksena.	Pedicels free and basal; upper horn longer and pointed and lower obscure; abnormal.

118.	*M. minuta*	...	$\frac{36M - 1OR}{H - 56}$; Hoshiarpur; 29th June 1956; Jaswant Rai Sharma.	Pedicels connate and slightly adnate; horns two, almost similar; abnormal.
*119.	*M. minuta*	...	$\frac{37M - 1OR}{SG - 56}$; Sagar; 7th June 1956; Srivastava.	Pedicels free and basal; horns two, upper longer and pointed; soral no. 11.
120.	*M. minuta*	...	$\frac{38M - 1OR}{R - 56}$; Rajkasvas, Marwar Jn.; 13th September 1956; K. M. Gupta and T. N. Bhardwaja.	Pedicels free and basal; horns two, almost similar; normal.
121.	*M. minuta*	...	$\frac{39M - 1OR}{DH - 56}$; Dhareshwar; Marwar Jn.; 13th September 1956; K. K. Sharma.	Pedicels free and basal; sporocarps slightly ribbed and bordered; horns two, upper longer and pointed, lower obscure; soral no. 12; normal.
122.	*M. minuta*	...	$\frac{40M - 1OR}{PA - 56}$; Pali; 13th September 1956; K. M. Gupta and party.	Pedicels free and basal; upper horn present, lower obscure; soral no. 14; normal.
123.	*M. minuta*	...	$\frac{41M - 1OR}{MD - 56}$; Madh Islands; 22nd September 1956; H. S. Santapau.	Pedicels free and basal; horns two, upper pointed upward, lower obscure; soral no. 12; normal.
124.	*M. minuta*	...	$\frac{42M - 2OR}{BH - 56}$; Bharatpur; 9th October 1956; Ganga Singh.	Pedicels free and basal; horns two obscure; soral no. 12; normal.
125.	*M. minuta*	...	$\frac{43M - 1OR}{BHIL - 57}$; Bhilwara; 12th February 1957; K. M. Gupta.	Pedicels free and basal; horns absent, soral no. 10; normal.
126.	*M. aegyptiaca*	...	$\frac{44M - 2OR}{BHIL - 57}$; Bhilwara; 12th February, 1957; K. M. Gupta.	Pedicels basal, solitary; sporocarps square, grooved, depressed; upper blunt horn present; soral no. 4-6; normal.

** Photographs and material kindly supplied from Bräun's original types by Dr. Meyr, Berlin.

* Species redetermined by the present authors.

DETAILS OF THE COLLECTIONS OF MARSILEA *IN SOME INDIAN HERBARIA*—(Contd.)

1 S. N.	2 Name of species	3 Herbarium details	4 Characters of the sporocarps
**110	*M. gracilenta* ...	$\frac{\text{28M — 1OR}}{\text{CN — 56}}$; Concan ; Dr. D. Meyr, Berlin.	Pedicels free and basal ; horns two, upper blunt, lower obscure.
**111.	*M. coromandelica* ...	$\frac{\text{29M — 1OR}}{\text{CM — 56}}$; India ; Dr. D Meyr, Berlin.	Pedicels basal and solitary ; horns two, almost similar and prominent.
112.	*M. minuta* ...	$\frac{\text{30M — 1OR}}{\text{DL — 56}}$; Delhi ; 2nd February 1956 ; T. N. Bhardwaja.	Pedicels free and basal ; horns two, upper inconspicuous, lower obscure ; soral no. 12 ; normal.
113.	*M. minuta* ...	$\frac{\text{31M — 1OR}}{\text{U — 56}}$; College compound, Udaipur ; February 1956 ; T. N. Bhardwaja.	Pedicels free and basal : horns absent ; soral no. 10 ; normal.
114.	*M. minuta* ...	$\frac{\text{32M — 3OR}}{\text{U — 56}}$; Aad river, Udaipur ; February 1956 , T. N. Bhardwaja.	Pedicels free and basal ; horns two, upper pointed, lower obscure ; soral no. 9 ; abnormal.
115.	*M. minuta* ...	$\frac{\text{33M — 1OR}}{\text{SD — 56}}$; Sarwad ; 8th March 1956 ; B. V. Ratnam.	Pedicels slightly connate and obscurely adnate ; horns two, inconspicuous, almost similar ; soral no. 9 ; normal.
116.	*M. minuta* ...	$\frac{\text{34M — 1OR}}{\text{T — 56}}$; Trichinopoly ; 5th March 1956 ; Miss M. Jaya Marie.	Pedicels slightly connate and basal ; sporocarps ribbed and bordered ; horns two, upper pointed, lower obscure ; soral no. 12 ; normal.
117.	*M. minuta* ...	$\frac{\text{35M — 2OR}}{\text{KO — 56}}$; Dadabari, Kota ; 20th June, 1956 ; V. K. Saksena.	Pedicels free and basal ; upper horn longer and pointed and lower obscure ; abnormal.
118.	*M. minuta* ...	$\frac{\text{36M — 1OR}}{\text{H — 56}}$; Hoshiarpur ; 29th June 1956 ; Jaswant Rai Sharma.	Pedicels connate and slightly adnate ; horns two, almost similar ; abnormal.
*119.	*M. minuta* ...	$\frac{\text{37M — 1OR}}{\text{SG — 56}}$; Sagar ; 7th June 1956 ; Srivastava.	Pedicels free and basal ; horns two, upper longer and pointed ; soral no. 11.
120.	*M. minuta* ...	$\frac{\text{38M — 1OR}}{\text{R — 56}}$; Rajkasvas, Marwar Jn. ; 13th September 1956 ; K. M. Gupta and T. N. Bhardwaja.	Pedicels free and basal ; horns two, almost similar ; normal.
121.	*M. minuta* ...	$\frac{\text{39M — 1OR}}{\text{DH — 56}}$; Dhareshwar ; Marwar Jn. ; 13th September 1956 ; K. K. Sharma.	Pedicels free and basal ; sporocarps slightly ribbed and bordered ; horns two, upper longer and pointed, lower obscure ; soral no. 12 ; normal.
122.	*M. minuta* ...	$\frac{\text{40M — 1OR}}{\text{PA — 56}}$; Pali ; 13th September 1956 ; K. M. Gupta and party.	Pedicels free and basal ; upper horn present, lower obscure ; soral no. 14 ; normal.
123.	*M. minuta* ...	$\frac{\text{41M — 1OR}}{\text{MD — 56}}$; Madh Islands ; 22nd September 1956 ; H. S. Santapau.	Pedicels free and basal ; horns two, upper pointed upward, lower obscure ; soral no. 12 ; normal.
124.	*M. minuta* ...	$\frac{\text{42M — 2OR}}{\text{BH — 56}}$; Bharatpur ; 9th October 1956 ; Ganga Singh.	Pedicels free and basal ; horns two obscure ; soral no. 12 ; normal.
125.	*M. minuta* ...	$\frac{\text{43M — 1OR}}{\text{BHIL — 57}}$; Bhilwara ; 12th February 1957 ; K. M. Gupta.	Pedicels free and basal ; horns absent, soral no. 10 ; normal.
126.	*M. aegyptiaca* ...	$\frac{\text{44M — 2OR}}{\text{BHIL — 57}}$; Bhilwara ; 12th February, 1957 ; K. M. Gupta.	Pedicels basal, solitary ; sporocarps square, grooved, depressed ; upper blunt horn present ; soral no. 4-6 ; normal.

** Photographs and material kindly supplied from Bräun's original types by Dr. Meyr, Berlin

* Species redetermined by the present authors.

THE LION OF THE GIR

BY

LT.-COL. A. H. MOSSE (Deceased)

[During his service as a Political Officer in western India between 1901 and 1936 or thereabouts, Lt.-Col. A. H. Mosse was a keen and active member of the Society and a frequent contributor to the *Journal*. Through the kindness of his widow we are privileged to reproduce a selection of chapters from his unpublished MS. entitled 'INDIAN HOURS WITH NATURE—being ramblings of a Naturalist-Shikari'. This article is the first of the series. Although in some cases the information may be rather out of date in fact and chronology, the articles are nevertheless of great interest as a contemporary record by an observant and knowledgeable sportsman and naturalist.—EDS.]

As there appears to be a good deal of misconception regarding the status of the Lion in India, it may be worth while to give a brief account of his real position at the present day [*c.* 1936].

It is not always realised that the lion, ordinarily looked upon as a native of Africa, had in historic times a habitat extending beyond the limits of that continent from Macedonia to Western Bengal—though the Old Testament should afford a reminder of its former existence in Palestine. Outside India, there is no doubt that the lion was still to be found in the remoter parts of Mesopotamia and southern Persia at the beginning of the present century. When in the Persian Gulf during the [first] Great War, I heard of definite evidence of its continued existence in both countries so late as the year 1917; but it is there almost certainly on the verge of extinction, if not absolutely extinct, today.

In India, apart from Kathiawar, the lion existed in diminishing numbers in Central India, in parts of Rajputana, and in north Gujarat up to the middle of the last century. Officers of the Central India Horse quartered at Goona during the first half of the century used to bag a number every year. The seventies, however, saw their final disappearance from these parts. The last indigenous lion in Central India—I say indigenous for a reason that will appear—is believed to have been one recorded as killed near Goona in 1873, while the last outside Kathiawar was shot by Col. Heyland of the old 1st Bombay Cavalry at Deesa in 1878.

The last stronghold of the lion in India was, and is, the Gir Forest in Kathiawar; there alone he has been able to maintain a footing up to the present time, by reason of the enlightened policy of strict preservation followed by the authorities of the Junagadh State. The present area of the Gir, within the boundaries of Junagadh, is not more than 500 square miles, and naturally the animals at times cross the borders into adjacent territories, where they are liable to come to grief. In Junagadh itself preservation was not always as strict as is now the case, and there is no doubt that at the close of the nineteenth century the lion in the Gir was nearer extinction than he is today.

During the late Lord Curzon's Viceroyalty, a certain amount of pother arose over an announcement that he was about to visit Junagadh for the purpose of shooting one of the few remaining lions. The feelings aroused on the subject found voice in some lines published in the leading Bombay daily. Of these I remember but a word or two contained in a plea that the lions of the Gir should be allowed to remain in their last retreat undisturbed by 'Viceroy or Vandal'.

It was rather hard on Lord Curzon. For this was the Viceroy who had laid himself out, as none before him, to preserve and restore the historic antiquities of the country in stone or marble or whatever lifeless medium. In the ear of such a man a tactful word, explanatory of the real urgency of the case of that still living antiquity, the Indian lion, would surely have received a sympathetic response, and have achieved as satisfactory a result as the cruel alliteration of that 'Viceroy or Vandal'. Great men must of necessity expect to be called hard names—but George Nathaniel Curzon a Vandal!

Whatever the method, the desired result was attained. Curzon went out to shoot no lion. And certainly that was just as well. For if not quite on the verge of extinction, the Indian lion at that date was very near it. It is said that in the late nineties its numbers had been reduced to less than a score. Indeed I have seen it stated that the lion had, in fact, all but disappeared, and that it was only saved from absolute extinction by the importation and turning loose in the Gir of a number of African lions. Well, my own connection with Kathiawar dates back over thirty years, and I have discussed the matter, both with Junagadh State officials and with officers of a previous generation of the old Bombay Political Department who were in a position to know, notably the late Colonel L. L. Fenton, a recognised authority. One and all have assured me that there was not a shadow of foundation for the story, and I have never heard of any sort of evidence in support of it. Its revival not long ago was possibly due to a misunderstanding or inaccurate recollection of an account of the late Maharaja Scindia's experiment when he did turn loose a few African lions in his own Gwalior Jungles (Central India) some twenty years ago. Of which more anon.

In any case, it is clear that the Curzon incident had the effect —I believe on Lord Curzon's own initiative—of bringing home to the Junagadh Durbar the necessity of more stringent measures of preservation. As a result of this stricter protection, for which every credit must be given to the State authorities, there has been during the last quarter of a century a not inconsiderable increase. It will be realised that any even approximately accurate census of the lions in the Gir is impracticable[1] but by those in the best position to judge the total number at the present time (1936) is variously estimated at from 80 to 150; the former figure, which is that given by Sir Patrick Cadell, the late Diwan of Junagadh State, is probably nearest the mark.

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[1] But see 'The Lion Census of 1955' by M. A. Wynter-Blyth (*JBNHS* 53: 527). This gives the total lion population in the Junagadh Gir as 290 animals.—Eds.

The task of preservation has its difficulties, outside the State territories as well as within them. Its own subjects the State can take measures to control, though considerable sums have to be paid as compensation to cattle owners. But the jungle area of the Gir, once 1,500 square miles and now but 500 in extent, is contiguous to several 'foreign' jurisdictions; and the lions do not always confine themselves within Junagadh limits. They are especially prone to wander during the monsoon months, with the object it is said of escaping from the attentions of mosquitoes and other biting insects which swarm at this season in the interior of the Gir.

The lion in India is the rarest of royal game, and invitations to shoot one are eagerly sought after. If the Nawab of Junagadh were to give full play to his hospitable instincts in this connection, it would speedily be wiped out. His feelings then can be imagined when he learns that a neighbour has invited a party of guests to shoot the lions which he himself might have offered but for his self-imposed duty of preserving the species.

That is one side of the question. On the other hand, the neighbour argues that he has the right to kill any wild animal which he finds in his territory doing damage to his stock. When that animal is a lion the temptation is strong to exercise that right, either in his own person, or by according the privilege to some distinguished visitor who could, perhaps, be attracted in no other way! It is further contended that the killing of occasional stray beasts can have no practical effect on the preservation of the species. Probably this would be true were no lions shot but adult males. But Junagadh has had just cause for complaint of the manner in which family parties of lionesses and young animals—the easiest to bag, but the breeding stock of the future—have sometimes been thoughtlessly destroyed.

It may be asked why such practices cannot be prevented by amicable agreement. The Agency authorities have always supported Junagadh in the matter. But it must be recognised that the traditional attitude of the Junagadh State in this connection has hitherto to some extent stood in the way. A simple request for co-operation in the preservation of a rare animal would, in the past, have received a more satisfactory response than what, in fact, used to be a demand based upon a claim as of right. For Junagadh has always rested its objection to the shooting of lions by its neighbours, in their own territories, on an unqualified claim to the ownership of all lions in Kathiawar, wherever found. That is a claim which no adjacent State, as a matter of sovereign prerogative, will admit. It is more than probable that all Kathiawar lions have, as alleged, been born within Junagadh limits. But they are *ferae naturae*, and their movements are subject to no control.

It may be hoped that this difficulty has now ceased to exist. For, as a result of a challenge by one of Junagadh's neighbours, this ownership question was not long ago made the subject of a formal decision on the part of the authorities of the Western India States' Agency, which is adverse to the Junagadh claim. With this contentious claim out of the way, and bearing in mind that, but for Junagadh, there would be no lions in existence, one may hope that the State will in future meet with a greater measure of genuine co-operation than it has received in the past. What would seem to be necessary is the making—and keeping—of a strict agreement between all the jurisdictions concerned as to the maximum number of lions that may be killed annually in each State, coupled with a definite understanding that lionesses and immature males are to be spared.

It remains to be seen whether, in the case of so large an animal as the lion, confinement to a small area will not eventually of itself result in extinction, by reason of the deterioration brought about by in-breeding. Records show that the average Indian lion of the past was in no way inferior to his African brother, but I understand that measurements of adult animals killed of recent years indicate a tendency to diminution of size.

It is quite a mistake to suppose that there is any specific distinction between the lions of Africa and India. An erroneous idea that there is such is perhaps traceable to the appellation 'The maneless lion of Gujarat' which at one time gained currency. This description was never justified. Maneless lions occur in the Gir as they do in parts of Africa; Patterson's notorious man-eaters of Tsavo, in East Africa, were entirely maneless. But the majority of adult males in Kathiawar have moderate manes, while I have seen Gir lions in captivity which possessed very fine manes indeed. It was the opinion of the late F. C. Selous that mane development depended mainly upon climatic considerations.

The modern story of the lion in India is not quite complete without reference to the, at first sight, mysterious appearance of two lions at different places in Central India a few years ago. It was, I think, in the year 1926 that a lion was shot near Jhansi and, some months later, another in the Panna State. The Maharaja of Panna, who shot the latter, himself told me that he had reason to believe there were a lioness and cub in the same jungle at the time; but, so far as I know, nothing more was seen or heard of these.

The explanation of these unexpected occurrences is almost certainly to be found in the fact that several years before, as I have already mentioned, the late Maharaja Scindia turned out some African lions in the Gwalior jungles. These beasts proceeded to make themselves a serious nuisance, and the Maharaja took steps to have them recaptured or destroyed. In this he was not entirely successful, as one or two animals remained unaccounted for. These, there can be little doubt, must have been the progenitors of the lions of 1926 occurring in the same part of India. It is not impossible that others still exist, but of course they could not be looked upon as indigenous Indian lions.

One has heard discussions as to whether the lion or the tiger is the more powerful beast. Such discussions lead nowhere, for no satisfactory conclusion can be drawn from the artificial conditions of captivity, while comparisons in the wild state are impracticable. It has, however, been put forward as an argument on behalf of the tiger that he has been responsible for the disappearance of the lion from a large part of India where the latter was formerly not uncommon, in fact that he drove the lion out.

From a melodramatic point of view the idea doubtless has its attractions. Picture the King of Beasts, his title to monarchy hitherto disputed by none. His wrathful amaze at the appearance of this formidable rival from the regions of the North. The Homeric encounters that followed as the battle-front extended its range. Victory in the balance, with the leonine ranks at long last giving way. The sullen falling back, first on the desert borders of Rajputana, next on the low jungle-clad hills of Gujarat. That last great battle on the banks of the Sabarmati, where the Tiger, victor once more but sore stricken, was forced to stay his advance; while the erstwhile Monarch, his ranks sadly depleted but his head unbowed, retired unmolested in the final retreat to the fastness of the Gir.

A drama, were it true, worthy of a more eloquent pen than mine. But evidence in support of its actuality there is none. For centuries both lion and tiger existed in numbers in Central India; why should the supposed aggressive superiority of the tiger have suddenly manifested itself in the nineteenth century? Scientific authorty, in the person of that eminent zoologist, Mr. R. I. Pocock, considers the cause of the disappearance of the lion undoubtedly to have been human agency. I am convinced that he is correct. The latter half of the nineteenth century in India was a period in which the spread of civilizing influences synchronised with a wider use of fire-arms. That the lion suffered more than the tiger was only the natural consequence of a difference in habits. He is more noisy than the tiger, has less dislike of comparatively open country, and will lie up for the day in lighter cover and less secluded spots. He is also much more gregarious. It follows that he is much easier to locate, and when found may be brought to bag in larger numbers at a time than is ordinarily the case with the tiger.

My own first active encounter with lions—in Somaliland—was with a troop, or pride, of six or seven animals, and considerably larger numbers than this have often been seen together. And the story, which I have now to relate, of a more recent experience illustrates the manner in which the lion will sometimes expose himself by day.

Towards the close of my service I held, for some time, an appointment on the Administrative Council of the State of Bhavnagar, included in the territory of which was an outlying area of partially jungle-clad hills bordering on the outskirts of the Gir. This area used, of recent years, to be regularly visited by lions during the monsoon season. But I had slain lions elsewhere, and had no intention of myself diminishing the small surviving lion population of India unless for some good purpose, even though there was no risk of the Junagadh policy of strict preservation being affected by the death of an occasional wanderer.

In the year 1930, however, I was approached by the authorities of the British Museum (Natural History) for assistance in the matter of obtaining for them specimens, hitherto lacking from the National collection, of the Indian lion. I was instrumental in sending them three old skulls, a gift from the Bhavnagar Durbar, but they wanted, if possible, at least one complete specimen for mounting whole. When, therefore, in August of that year, information came in one day of a pair, lion and lioness, having crossed our border and killed a cow and a buffalo, I determined to seize the opportunity.

It was about 1 p.m. the following day when I reached my first objective, a tiny bungalow near the border, which served as a sort of shooting-box. There I learned that the lions had not returned to their buffalo kill the previous night, but that they had been heard roaring in the early hours of the morning and three parties of local *pagis* (trackers) were out trying to locate them. Little more than an hour later a messenger arrived with the news that the lions had been marked down not more than two miles from the bungalow. I at once hurried off, accompanied by my Superintendent of Police, a Rajput officer named P.

In due course our guide brought us to a long narrow hill, at the further end of which three *pagis* were lying down on the watch. We crept up and dropped down by their sides. The time was between 3.30 and 4 p.m., on a fine afternoon with intermittent sunshine.

In order to make clear what followed I must try to give some idea of the lie of the land and the character of the ground. The hill upon which I found myself was somewhat sparsely overgrown with coarse grass, with isolated trees and occasional bushes dotted about. At the end of the hill the crest dipped to a moderately steep descent for thirty yards or so, then sloped away more gradually for perhaps another eighty, beyond which the land rose again to a rather higher level than my own position. The face of this opposite hill was fairly open grass land, but to my right front and lower down the hillside was a wooded area within which the head shikari informed me the lions were concealed.

I had no time to question him. The words were hardly out of his mouth when, from the cover facing me on the right, there emerged a lion who proceeded to walk leisurely across my front on the open hillside, at a distance of between 150 and 200 yards. I at once crawled forward and squatted behind a tiny bush about two feet high and ten or twelve paces from the edge of the hill-crest. It should be understood that, from the crest immediately in front of the spot where I sat, there was a space, extending directly below the edge for some thirty yards or so, that was not within my sphere of vision. About fifty yards below the crest there was a patch of cover, consisting of high grass interspersed with bushes, which stretched across the slope beneath me from left to right, part of it reaching as far as the blind area to which I have alluded.

I sat and watched the lion strolling with apparent aimlessness about the hillside opposite, my mind busy with alternative schemes. I could see no sign of a mane, but the beast was, I thought, too big for a lioness. Should I wait in the hope that the other animal of the pair would join its mate and solve the doubt, or should I back my belief that this was the male and seize the opportunity in the event of its offering a broadside standing shot? The range was not more than 150 yards and I had faith in my .318. None the less I should be happier were I in a position to use my heavier weapon, a twelve-bore magnum Paradox. It is the first shot that counts, and a wounded lion is apt to mean danger for others besides oneself. As a matter of principle therefore I believe in close range, as well as a heavy bullet, for all dangerous game. I had never yet fired a shot at a dangerous beast at a three-figure range in yards, and did not want to begin now. I had indeed been so fortunate with Somali lions as to have been able to make twenty-five yards—and that always on foot—my maximum range. To lay this down as a record to be maintained would be foolish, circumstances must decide; all the same it would be pleasant to maintain it.

Of alternative courses, then, there appeared to be three: (*a*) to sit still and await events, (*b*) to attempt a stalk along the edge of the cover whence the lion had come, or (*c*) to look for a suitable point of vantage up to which the half dozen men at my disposal might make a bid to drive the beast. The problem was, however, complicated by the existence of the animal's mate, the position of which was not known, though presumably somewhere close at hand.

At what conclusion I might have arrived I cannot say, for I had not been watching it for more than four or five minutes when my proposed quarry settled the matter for itself, turning in my direction and walking down the hill towards me. It continued its way to the foot of its own hill and then proceeded to walk up mine. Now, as it faced me, at a distance which had been reduced to eighty yards or so, it was obvious from the size of the massive head that, mane or no mane, this was no lioness but an adult male lion. Quietly I laid aside the .318, picked up the Paradox, and waited. Still the distance lessened and now the lion, moving leisurely as ever, had reached the narrow patch of cover fifty yards below. 'When he passes that . . .' thought I, as he entered the cover and was lost to view.

I have said that this patch of cover linked up the open ground with the blind area beneath the crest. The lion did not emerge on the visible part of the near side of the cover as I had hoped. I waited. One, two minutes . . . ? Should I crawl forward and peep over the small boulder which marked the edge of the crest in front? Came an inarticulate sound from P. just behind me, his finger pointing forward over my shoulder—he is quicker of hearing than I, who am a trifle deaf—then on my ears too a peculiar noise, what was it? Next moment I realised, the breathing of the lion! And the next moment after that, rising silently above that boulder, then motionless, with eyes that seemed to be staring straight into mine, though I fancy they were looking just past me, the head and neck of the lion himself!

Face to face at a dozen paces, and I was sitting on the bare ground! But, though I certainly had not a second to spare, I was ready for him; he was not ready for me. Fortunately, too, my gun was already pointing straight in his direction; I had to make no lateral movement, only to raise it to my shoulder. Afterwards I fancied that, as I pulled the trigger, I had seen realisation dawning in his eyes. But my bullet was in his throat, and he collapsed out of sight behind the boulder.

The word 'unique' is often misused, but I think it really was applicable to this experience. And I had maintained my record in unlooked for fashion. The explanation of the lion taking the line he did probably lay in the fact that he had not dined the previous night and, beginning to feel hungry, had decided to move towards his kill of two nights before. My position just happened to lie directly in his path. It was a great stroke of luck that I arrived when I did, before he was on the move; I was only just in time. We saw nothing of the lioness, but heard her that night calling for her mate.

This proved to be an adult male in his prime, though practically devoid of mane. I had my work cut out that evening and next day, without expert assistance, to prepare the whole skeleton as well as skin and skull, in view of his eventual destination; but it was done, and in the afternoon he was packed off to Bombay. Subsequently a pair of lions were presented by the Nawab of Junagadh to the British Museum, and it was decided to retain mine for the Bombay Museum. There, so far as I know, he may be seen today.

In a letter from my friend P. not long ago he remarked that, whenever he thinks of the finale of the incident just described, he feels his hair stand on end. As well it might: it is all very well for the principal on such an occasion, with confidence in himself and his weapon, to choose, so far as the enemy permits, his own moment for action. It is a very different matter for the looker-on within the danger zone, bound to hold his hand and wait upon the initiative of another. Rather like sitting beside the driver of a fast car when the going is dangerous; he is probably in complete control of his machine, but appears to you to be taking appalling risks.

No novice at the game, P. has himself a tale to tell of a remarkable experience; a tale which he has written down for me, and which I shall take the liberty of relating, as nearly as may be, in his own words:

'It was in the year 1911 or 1912 that I was arranging a lion shoot for His late Highness, the Maharaja of Bhavnagar, when I witnessed the following scene:

'I was tying up buffaloes at two different places in that part of the Gir Forest which is in the Amreli District belonging to the Baroda State. It was about the middle of March. On the third day one *pada* (young buffalo) was killed by a pair of full-grown lions. I put up a machán at the same place, and informed H.H. at Bhavnagar about the kill, requesting him to come immediately.

'Next evening we tied a full-grown *pada,* about two years old, and I sat up on the machán with a shikari to make sure that a male lion was there. Visibility was good when the pair of lions arrived about sunset. First to appear on the scene was a full-grown male lion; following him, about thirty yards behind, was his wife. The *pada* was tied up in a *nála* (nullah), the banks of which were about four to six feet high; the machán was situated in a tree on one bank. The *nála* was dry and about twenty yards from the *pada* was a small temporary well, dug for watering cattle, with a trough alongside.

'The lion approached cautiously at first and had a drink from the trough, then, after circling round the machán and bait, he suddenly rushed at the *pada* but, shirking at the last moment, he turned aside before quite reaching it and disappeared. Within two minutes he made a second big rush, doing the same thing again. All this time his wife was sitting in the *nála* about thirty yards away. When the lion turned away twice, she rushed straight from where she was sitting, jumped on the *pada* from behind and, coming on to its back, killed it after a great effort. In this *tamasha* (display), the peg to which the bait was tied came out of the ground and the buffalo was killed outright—presumably its neck broken—at about ten yards from the spot where he had been tethered.'

'After killing, the lioness dragged the carcase for a few feet and suddenly, with a terrific pull or jump, she managed to throw the dead *pada* up on the far bank of the *nála*. While this was going on the lion was out of sight, but he soon appeared when his mate began to start her meal; but on his coming near to take part in the feast a terrific quarrel occurred, after which the *pada* was dragged still farther away by the lioness into the jungle out of my sight. For another ten minutes or so I heard the noise of their occasional quarrelling, but after that all became quiet, and I could only occasionally hear the noise of the cracking of bones, or at times little friendly noises; the quarrel had evidently been squared up.

'Next morning I took up their tracks and located them about a mile and a half away. His Highness had arrived by then and in due course he shot the lion, while she fell to my gun in a beautiful beat with only twenty-five beaters.'

It is a story with several interesting features. With panthers, the female usually makes the kill, if the quarry be not too big for her. I do not know that this is generally the practice with lions. In any case, the buffalo in this instance, though not fully mature, was a big animal, and it was clearly a job for the husband. Individual characters, however, vary among beasts as among men; it would seem that courage was not this particular lion's strongest point, or else he was, for some reason, not feeling quite at his best that evening. His mate was made of sterner stuff; there is an almost human quality about her impatience at his twice repeated failure and the determination with which she stepped in to finish a business which might have been supposed to be beyond her powers. And the subsequent quarrel, of which she did not have the worst, if he funked the kill he should jolly well wait his turn to dine!

Again, P. was unable to see exactly how the lioness contrived to hoist the *pada* up on to the bank at least four feet above her. But he is quite definite as to her having done so by a single exertion of strength; it can I think only have been by a scramble up the bank, dragging her prey at her side. It was a remarkable feat, for the buffalo cannot have weighed much less than 600 pounds, while the weight of an adult Gir lioness would hardly exceed 250 pounds at the outside.

It is perhaps worth mentioning that the skulls of this pair of lions were two of the three subsequently presented to the British Museum by H.H. the present Maharaja of Bhavnagar, and which were described in detail by Mr. Pocock in his article on the Lions of Asia in Vol. XXXIV (p. 638) of the *Journal of the Bombay Natural History Society*.

(*To be continued*)

NOTES ON THE *BRÜELIA* GROUP OF MALLOPHAGA (FEATHER-LICE), WITH DESCRIPTIONS OF FOUR NEW SPECIES

BY

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(*With four text figures*)

Significant success has already attended the study of the relationships of different mallophaga in their bearing on the phylogeny and systematics of their avian hosts (see Clay, *JBNHS* 49: 430-443, December 1950).

The main difficulty lies in the fact that a great many mallophaga are as yet insufficiently known, or not at all. Even so there are a few groups about which our knowledge is fairly satisfactory, though in others there is still much confusion. This confusion is partly the result of faulty collecting techniques, particularly in cases where special methods are called for. For example, from the 'song birds' (passerines) we normally obtain species of *Docophorulus* (Philopterini) which in a dead bird soon make their appearance on the outer surface of the head feathers. Even in the case of a living bird with the head firmly secured and the feathers of the hindcrown turned over one by one, I have found it easy to pick up with a pair of tweezers specimens of *Docophorulus* from near the surface.

However, with *Brüelia* species this is not so easy. It had puzzled me at first as to why this genus was so poorly represented numerically among collections received from correspondents, and why the Philopterini were always so much more abundant. It was only when actually collecting myself that I discovered how difficult it was to obtain Brüeliini from the plumage of living song birds. Even in the case of dead birds Brüeliini often appear on the surface only some days after their host being killed. In fact sometimes even after days they do not show up at the surface, and they only fall out when the carcase is vigorously shaken.

For studying mallophaga one may sometimes depend on shaking out bird skins in ornithological collections in this manner to obtain the dead feather lice. By this method one may expect to get *Brüelia* spp. relatively easily. Quite the opposite is the case with the amblycerous feather lice (Colpocephalidae and Menoponidae) which try to abandon their host soon after its death. Thus they will not be found in the plumage of museum specimens so commonly.

The above method of shaking out the mallophaga from museum skins is, however, fraught with some danger of unreliability. During the course of preparation, the skin might have got 'tainted' with some mallophaga which do not belong to itself but to another bird with which it may have accidentally come in contact. Especially where single specimens of mallophaga are concerned caution becomes necessary. But even in cases where greater quantities of certain mallophagan species are found, a suspicion still lingers that a false diagnosis might have been facilitated in this manner.

On account of their habits it is somewhat unusual to find the Brüeliini on a freshly killed bird. These often leave the plumage only after a day or two, and therefore it is necessary to put away the carcase for this time. But in that case the bird's body is likely to become useless either for skinning or for eating.

I have observed that the Brüeliini normally appear on the belly region of a dead bird. Therefore it seems reasonable to conclude that this region is the natural 'habitat' of the *Brüeliae*. Unfortunately almost nothing is known about the bionomics of the various *Brüelia* spp. Even the data concerning their occasional blood meals—based on Nitzsch's observations, which we find interspersed in Giebel's monograph—are not entirely free from doubt.

Concerning the eggs it may perhaps be useful if I quote here Pfleger's hitherto unpublished description of those of *Brüelia nebulosa*. This author found the *Brüelia* eggs on the Starling (*Sturnus vulgaris*) on the underside of the side feathers of the crop, on the upper breast, and the lower back. The eggs are attached to the radii by means of a white cement. The arrangement of the eggs is similar to that in other Brüeliini. Their shape is somewhat stretched (long and narrow). The egg-shell, including the egg-cap, is white to weak yellowish, with a surface like fine shagreen leather; the egg-cap bears a flagelliform appendix. The openings of the micropylae are placed on low pustules which stand in an irregular circle on the edge of the cap.

The systematic investigation of the Brüeliini leaves much to be desired. It is the merit of Keler to have erected the genus *Brüelia* and to have contributed in some measure towards the determination of its species. But the knowledge of forms within the genus had not been essentially widened by him. My own review (1946) cannot be interpreted otherwise than as purely tentative, as an attempt to put in order the hitherto described mallophagan species and, as far as possible, to ascribe them to the hitherto recognized genera.

The Brüeliini of the song birds are characterized by two peculiarities: first, closely related or even identical forms live on host species which, in some cases, are very different. For instance Keler 1936*c* reports that he was unable to distinguish *Brüelia trithorax* of *Paroaria cucullata* (a West Indies finch) from *Brüelia cyclothorax* of *Passer montanus* (the Tree Sparrow) and *Fringilla montifringilla* (the Brambling). Secondly, it has recently been found that near relations of the genus *Brüelia* (*sensu stricto*) live on some of the same birds. For instance, thrushes of the genus *Turdus* are infested, besides the genus *Brüelia*, by species of *Allobrüelia* and *Turdinirmus* also.

Further investigation of the Brüeliini is urgently needed for a proper understanding of the species. To assist such an investigation I give below the diagnoses of some new species of the *Brüelia*-relationship.

It will probably be necessary to erect some new generic groups of Brüeliini when we come to know more of the forms. Even today this is true of the differentiation of *Brüelia* and *Allobrüelia*. In some cases it is difficult to decide if a certain species from other bird-hosts than *Turdus* spp. should be ascribed to the one genus or the other. But the allocation of mallophaga from a bird other than *Turdus* species to the genus *Allobrüelia* may, in the present state of our knowledge, be considered somewhat questionable. Therefore my ascribing to this genus the two new species described below, namely *rhinocichlae* and *museiberolinensis*, from members of the families Sturnidae and Timaliidae respectively must be treated as provisional.

Allobrüelia museiberolinensis spec. nov.

In the collection of the Zoologisches Museum, Berlin, from *Mino dumontii kreffti* Scl. (Fam. Sturnidae). Locality 'Bismarck-Archipelago' (slides WEC 2072).

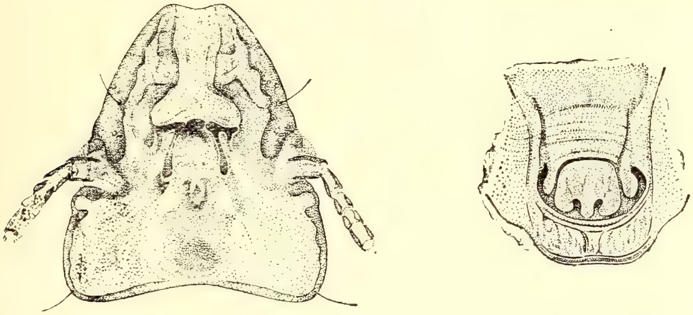

FIG. 1. Head and male genitalia of *Allobrüelia museiberolinensis* spec. nov. from *Mino dumontii kreffti*. Drawn by P. Rose from slide WEC 2072.

The new species, which otherwise resembles the *Allobrüelia*-type is characterized by the rather heavy thickened limbus zygomaticus (fig. 1). Holotype slide no. WEC 2072 ♂, allotype no. 2072 ♀; the others paratypes.

Allobrüelia rhinocichlae spec. nov.

In Mjoberg's Sumatra collection in the Riksmuseum, Stockholm, from *Rhinocichla mitrata* (*mitrata*) S. Müll. (Fam. Timaliidae) (slide WEC 2257).

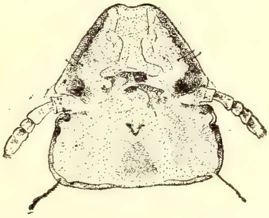

FIG. 2. Head of *Allobrüelia rhinocichlae* spec. nov. from *Rhinocichla mitrata*. Drawn by P. Rose from slide WEC 2257.

The new species is readily distinguished from the type of *Allobrüelia amsel* by the form of the head as represented in fig. 2, as well as by the straight-sided (almost quadrangular) signature of the clypeus. Furthermore *A. rhinocichlae* nov. spec. has the edges of the osculum more rounded, the forehead is more slender, the antennae are more thickened (whilst in *A. amsel* they are rather slim) and the sides of the hind head are more trapezoidal (in the case of *A. amsel* they are pronounced convex rounded). Holotype slide no. 2257.

Brüelia fulmeki spec. nov.

From a specimen labelled '*Calornis payanensis*' [*Aplonis panayensis strigatus* Horsf. (Fam. Sturnidae)] Locality Medan (Sumatra), slide no. WEC 785.

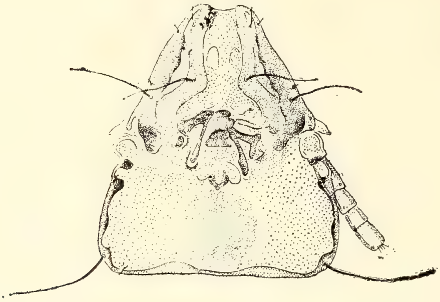

FIG. 3. Head of male of *Brüelia fulmeki* spec. nov. from *Aplonis panayensis strigatus*. Drawn by P. Rose from slide WEC 785.

The new species is characterized by its straight-sided forehead which is trapezoidal and has a narrow, rather deep osculum and a broad and vigorous limbus zygomaticus. The clavi are large and pointed. The species stands somewhat far removed from *Brüelia* (*sensu stricto*), and shows no near relationship, e.g. to *B. nebulosa*. Perhaps it would be necessary to separate the species generically. Fig. 3 shows the head of the male. Holotype slide ♂ no. 785.

Brüelia muniae spec. nov.

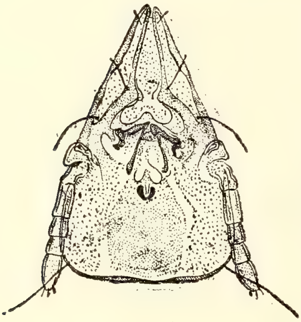

FIG. 4. Head of female of *Brüelia muniae* spec. nov. from *Munia maja*. Drawn by P. Rose from slide WEC 774.

One female only (slide no. WEC 774, holotype). Host *Munia maja* (Linn.) (Family Ploceidae, Subfamily Estrildinae). Locality Medan (Sumatra, O. K.).

The new species is characterized by the straight-sided forehead which is long-stretched and triangular. Osculum moderately deep and so narrow that the configuration of a food-channel is clearly visible. Clavi short and blunt, like trabeculae. Contrary to this, the antennae are strikingly strong and long. The species is rather remote from *Brüelia* (*sensu stricto*). Undoubtedly it will be necessary to separate it generically. Unfortunately I do not know the male. The head of the female is shown by fig. 4. Holotype ♀ 774.

BRIEF NOTES ON CROP PESTS AND THEIR CONTROL IN THE PANJAB (INDIA)

BY

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(*With* 34 *text figures*)

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INTRODUCTION

Stepping up food production is the most serious problem of the day and plant production is directly associated with it. Both our Government and the public in general are equally interested in meeting this problem successfully. Accordingly, it is most desirable to record brief information on the activities, prominent characters, and the nature of damage of some important pests which usually hinder crop production and consequently handicap progress. At the same time, it is desired to acquaint the cultivators with some basic knowledge of the preventive and control measures recommended against different pests. Besides helping the farmers, it is also presumed that this information will stimulate interest in the staff engaged to 'grow more food' in various departments to take up prophylactic measures against the common pests.

Therefore, with a view to imparting some general information on the subject, an almost complete list of the pests met with in the Panjab, including some minor ones also, is arranged cropwise.

I am extremely thankful to S. Gurcharan Singh Sohi, Assistant Professor of Entomology, Government Agricultural College, Ludhiana, for the help rendered in the compilation of the list of crop pests.

The illustrations in the article are drawn from various sources, particularly the following: Proceedings of the Entomological meetings, Pusa; Handbook of Economic Entomology for South India, by Dr. T. V. Ramakrishna Ayyar; Insect Pest Number, by Dr. Khan A. Rahman; Agricultural Zoology, by Dr. K. W. Dammerman; and Elements of Plant Protection, by Dr. Leuis L. Pyenson. To all these sources my grateful acknowledgement is offered. The sketches were kindly prepared by S. Sant Singh Sekhon, Research Scholar, Panjab University, Hoshiarpur, to whom I wish to express my appreciation.

1. PESTS OF SUGARCANE, *Saccharum officinarum*

Planted in March and harvested from December to April.

(A) **Pests attacking Setts and Roots**

1. White ant, *Microtermes obesi* Hol. and other species (Termitidae; Isoptera) (Fig. 1). A serious pest throughout the Panjab. The attacked setts may fail to germinate.

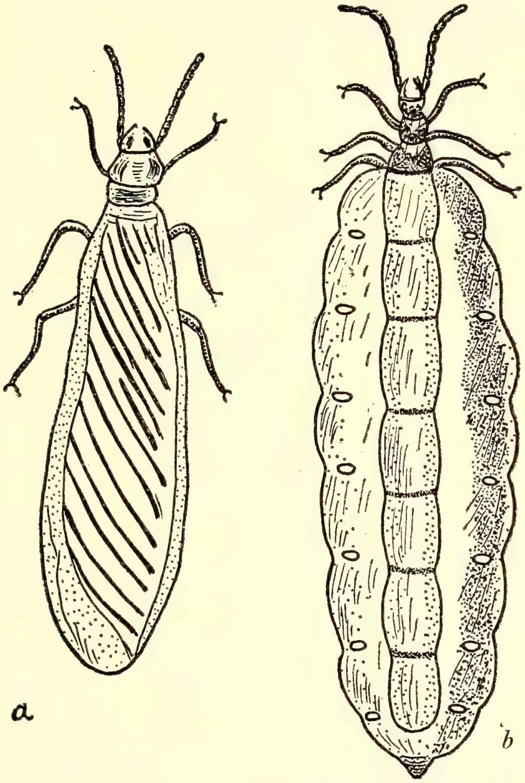


Fig. 1. Termite species, (*a*) Winged male ×3, (*b*) Queen ×$1\frac{1}{3}$.

Control: To protect the setts (i) their ends may be dipped in sanitary fluid or (ii) BHC be dusted near the planted setts.

2. Mole Cricket, *Gryllotalpa africana* Pal. (Gryllidae; Orthoptera). A minor pest in some parts of the State. It damages the roots by burrowing into the soil.

Control: Poison baiting with bran, sodium fluosilicate, or BHC and *gur*.

(B) **Pests feeding on Leaves**

(*a*) Biting:

1. Grasshopper, *Hieroglyphus banian* Fb. (Acrididae; Orthoptera) (Fig. 2). Occasionally a major pest in sugarcane growing areas. It also attacks rice, maize, 'bajra', and 'jowar'. Adults have pale

greenish patches and four black transverse furrows behind the neck. Nymphs are yellowish with reddish brown dots and patches. Both adults and nymphs damage the young crop by feeding on leaves. Active during May to July, only one brood a year.

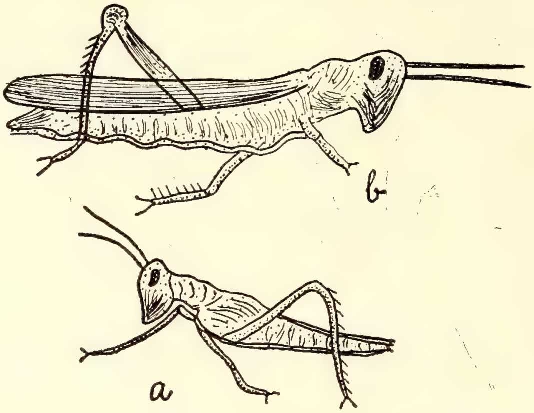


Fig. 2. Grasshopper *Hieroglyphus banian* Fb.,
(*a*) nymph ×1½, (*b*) adult ×1½.

Control: (i) Plough up the affected fields and *bunds* after harvest, (ii) poison baiting with bran, sodium fluosilicate, or BHC and *gur*, and (iii) dusting with 10% BHC.

(*b*) Sucking:

1. Leaf hopper, *Pyrilla perpusilla* Wlk. (Fulgoridae; Homoptera) (Fig. 3). A major pest in Ludhiana, Hoshiarpur, Jullundur,

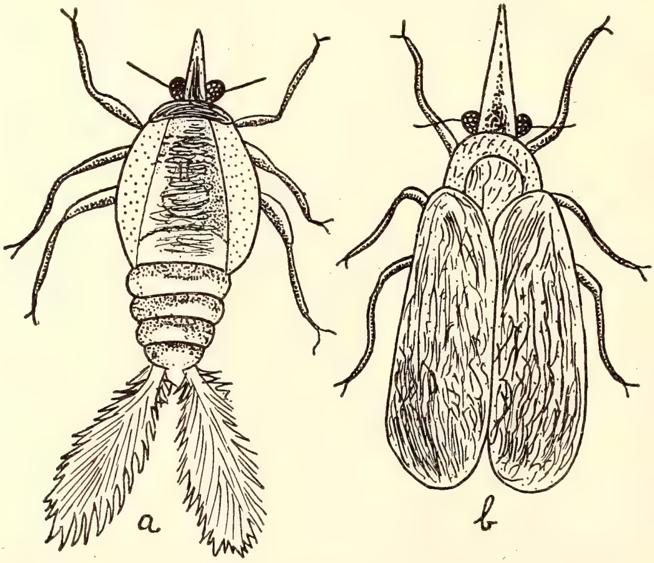


Fig. 3. Leaf Hopper, *Pyrilla perpusilla* Wlk., (*a*) nymph ×5, (*b*) adult ×5.

Gurdaspur, and Karnal districts. Alternative food plants are wheat, barley, oats, 'chari' (*Sorghum vulgare*), maize, 'bajra', 'baru' (*Sorghum halepenae*), and other grasses.

Adults are straw coloured, nymphs pale yellow with a pair of long waxy filaments at the hinder end. Both the stages suck sap from the leaves which dry up. They also secrete 'honey dew' on which black fungus develops and imparts a sooty appearance to the leaves and interferes in their photosynthetic activities. Active on sugarcane from May to December, with 4-5 generations a year.

Control: (i) Collect adults and nymphs by nets or bagging and destroy them in kerosinized water, (ii) dust the crop with 10% BHC with the help of hand or power dusters.

2. Black bug, *Micropes excavatus* Dist. (Lygaeidae; Heteroptera). A serious pest in Kangra and Karnal districts but minor in others. Adults black with apex of front wings white. Both adults and nymphs suck the leaf sap and plant growth is checked and the quality of *gur* adversely affected. Active from March to October with about three broods.

Control: Dusting with 5% BHC or spraying with Nicotine Sulphate 1 : 800.

3. White-fly, *Aleurolobus barodensis* W. (Aleurodidae; Homoptera) (Fig. 4). A major pest in factory areas. The nymphs desap the

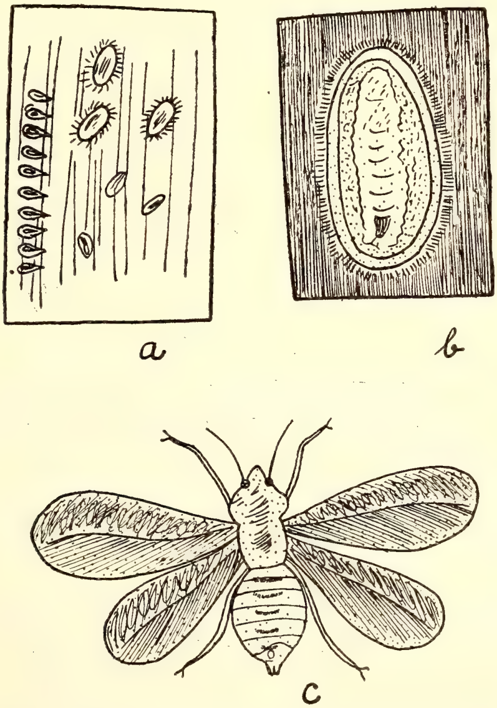


Fig. 4. Whitefly, *Aleurolobus barodensis* W., (*a*) a row of eggs and nymphs on leaf, (*b*) fully grown nymph × 11, (*c*) × 11 adult.

leaves which turn pale and wither. Active during summer when the leaves become black due to mould which develops on the 'honey dew'.

Control: (i) Collect and burn all infested leaves, (ii) spray the crop with fish-oil rosin soap, or rosin compound, (iii) dust with 5% BHC or spray 0.05% wettable DDT against the adults.

4. Sugarcane mealy-bug, *Trionymus sacchari* Gr. (Coccidae; Homoptera). A minor pest in the sub-mountain regions. The adults and nymphs feed at the base of the leaves and suck juices. Active from November to March.

Control: (i) select pest-free setts for planting, (ii) remove and burn infested leaf sheaths.

(C) **Borers**

1. Top borer, *Scirpophaga nivella* F. (Pyralidae; Lepidoptera) (Fig. 5). A major pest throughout the sugarcane tract, also recorded from 'sarkanda', 'mandal', and guinea grass. Adults white, females with their abdominal end set with yellowish brown hairs. The caterpillars bore through the leaf mid-rib and reach the base of the whorl and cause 'dead heart' in the young plants during early growth and the canes give out top branches. Active from March to October with about five generations.

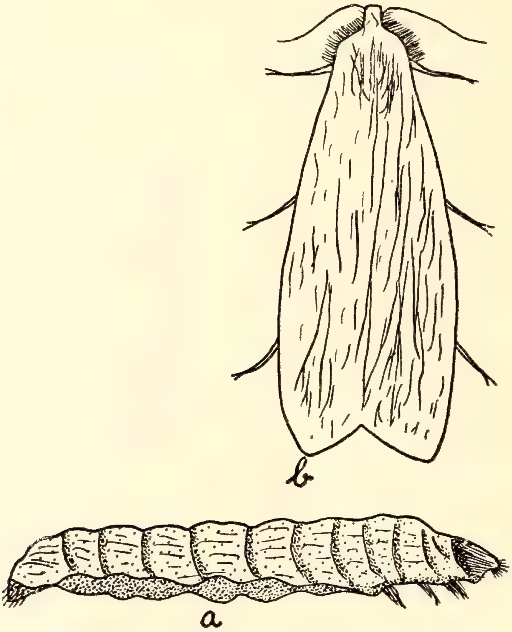


Fig. 5. Top borer, *Scirpophaga nivella* F., (*a*) full grown larva ×2½, (*b*) moth ×3½.

Control: (i) Collect and destroy the moths and egg clusters during March-May, (ii) remove and burn or feed to cattle all infested top shoots.

2. Stem borer, *Argyria sticticraspis* Hamp. (Pyralidae; Lepidoptera). A major pest, widely distributed in the State. Alternative food plants are 'bajra', 'sarkanda', 'baru', 'swank', and guinea grass. The caterpillars are dirty white with *five* longitudinal stripes. They bore and feed into the stem and produce 'dead heart'. Active from March to October but damage is serious during April-June. May have 5-6 generations during the active period.

Control: (i) Plough up cane field soon after harvest and burn all up-rooted stubble, (ii) earth up the plants twice or thrice by the end of May.

3. Pink stem borer, *Sesamia inferens* Wlk. (Noctuidae; Lepidoptera). A minor pest, recorded on sugarcane, wheat, and barley in Gurdaspur and Hoshiarpur districts. Caterpillars bore into stem and cause 'dead heart'.

Only preventive measures such as removal of infested plants showing 'dead heart' and destruction of stubble are recommended.

4. Gurdaspur borer, *Chilo trypetes* Bisset (Pyralidae; Lepidoptera). A very serious pest in Gurdaspur district and Mukerian Tehsil in Hoshiarpur. Its spread in the neighbouring districts is being noticed gradually. Recorded only on sugarcane as yet. The caterpillars are creamy white in colour with four longitudinal reddish brown stripes. They bore into the stem and make spiral tunnel. The attack causes the entire whorl of leaves to dry up which gives a blighted appearance to the crop. The pest is active from July to October with two generations.

Control: The stubble should be uprooted, collected, and burnt to destroy hibernating caterpillars.

5. Root-borer, *Emmalocera depresella* Swin. (Pyralidae; Lepidoptera). A minor pest but widely distributed throughout the State infesting 'baru' and 'sarkanda' grasses besides sugarcane.

Control: Only prophylactic measures are recommended.

2. PESTS OF FIBRE CROPS

COTTON *Gossypium herbaceum* L. Sown in April-May; flowers in July-September; picking from October to January.

(A) **Pests attacking Roots**

1. White ants, termites (*vide* sugarcane).

Avoid green manuring or unripe farmyard manure and apply optimum number of irrigations as prophylactic measures.

(B) **Pests on Seedlings**

1. Surface Grasshopper, 'Toka', *Chrotogonus* sp. (Acrididae; Orthoptera). A minor pest but occasionally causes considerable damage to germinating cottons, particularly in Ferozepore District. Both the adults and the young are destructive. Active throughout the year and infests maize, tobacco, 'bhindi', potatoes, lucerne, and 'toria', besides cotton.

Control: (i) Poison baiting with sodium fluosilicate or BHC, (ii) dusting with 5-10% BHC (15-25 lb. per acre) in case of severe attack.

2. Grasshopper, *Ailopus* sp. (Acrididae; Orthoptera). A minor pest, both the adults and young ones feed on seedlings. Active from May to October. Control as above.

3. 'Tid', *Gryllus viator* Kley. (Gryllidae; Orthoptera). A serious pest of germinating cotton in the south-eastern districts particularly Karnal and Hissar. Both the adults and young destroy the seedlings at night and the adults are numerous during May-June.

Control: Baiting with poison-bran or light dusting with BHC5%.

4. Grey Weevil, *Myllocerus blandus* Fst. or *M. maculosus* Desb. (Curculionidae; Coleoptera). Minor pests, the adults cut the seedlings near the ground level at night or early mornings. The grubs damage the roots. Active during summer and also feeds on maize and 'jowar'.

Control: Hand picking or shaking the infested plants over buckets containing kerosinized water to kill adults and ploughing after harvest to destroy the immature stages.

5. Lucerne Caterpillar, *Laphygma exigua* Hb. (Noctuidae; Lepidoptera). A minor pest but occasionally it may destroy the seedlings during May when this crop is near lucerne fields.

Control: Spray with any stomach poison as lead arsenate-2 lb. in 100 gallons of water.

(C) **Pests feeding on Leaves**

(*a*) Biting:

1. Cotton Leaf Roller, *Sylepta derogata* Fb. (Pyralidae; Lepidoptera) (Fig. 6). A sporadic pest of American Cottons in Amritsar, Jullundur, Ferozepore, and Karnal districts. Alternative hosts are a number of wild plants. Adults yellowish white, wings spotted with dark brown dots and wavy lines. Young caterpillars yellowish, feed on the under surface of leaves, but the grown up ones roll the leaves and feed inside. The attacked leaves are shed ultimately. Active from April to November.

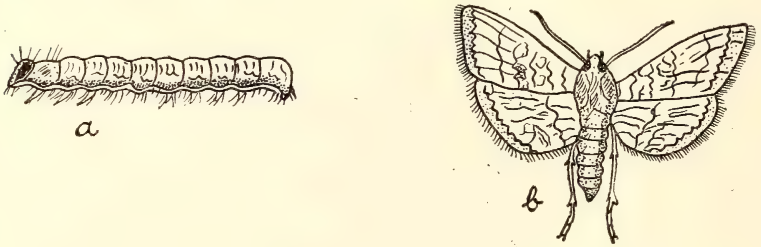


Fig. 6 Cotton Leaf Roller, *Sylepta derogata* Fb., (*a*) larva ×1½, (*b*) moth ×1½.

Control: (i) Collect all rolled up leaves and burn, (ii) spray with lead arsenate or 50% wettable BHC at 0.15% strength and (iii) deep ploughing after harvest to destroy pupae.

2. Cotton Semilooper, *Tarache notabilis* Wlk. (Noctuidae; Lepidoptera). A minor pest at Hansi and Gurdaspur. Moths with white wings decorated with dark markings. Dark green semiloopers feed on leaves. Active from April to September.
Control: Hand picking of moths and larvae.

3. Bud Moth, *Phycita infusella* Meyr (Pyralidae; Lepidoptera). A minor pest. The greenish caterpillars which have faint brown stripes tie the bud leaves and feed inside. The infested leaves wither and are shed. Conspicuous damage may be observed during June-July.
Control: Spray with lead arsenate or BHC 50% wettable at 0.15% strength.

4. Bhindi Caterpillar, *Acontia* sp. (Noctuidae; Lepidoptera). A minor pest. Moths with bright lemon-yellow wings; semiloopers green, feed on leaves. Active during summer.
Control: Hand picking of moths and larvae.

5. Lucerne Caterpillar (*vide* seedlings). The caterpillars feed on leaves and in severe cases of attack the plants may be entirely defoliated.

6. Cotton Grey Weevil (*vide* seedlings). Both adults and grubs are harmful. Adults grey with a number of dark brown spots on the front wings. They cut the leaf margins and also feed on buds and young bolls. The immature stages live underground.

(*b*) Sucking:

1. Jassid, *Empoasca devastans* Dist. (Jassidae; Homoptera) (Fig. 7). A major pest of American cottons particularly in Ferozepore and Hissar districts. Besides cotton, the pest is also destructive to 'bhindi', potatoes, and brinjals. The adults are yellowish green with

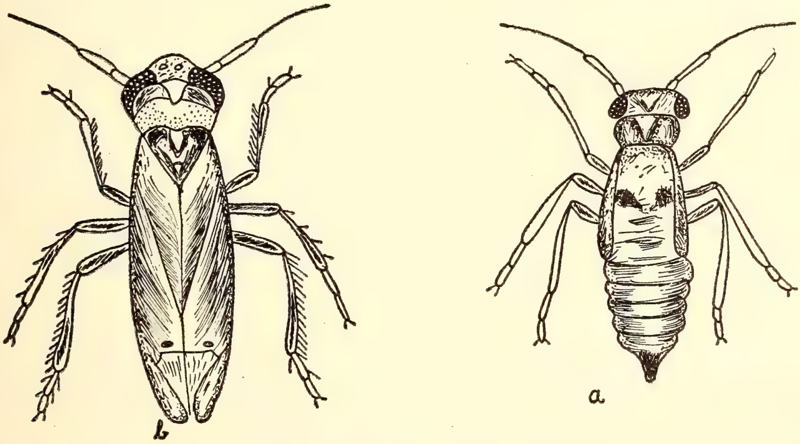


Fig. 7. Cotton Jassid, *Empoasca devastans* Dist., (*a*) nymph × 9, (*b*) adult × 9.

a black dot on each front wing and two such dots on the head. Both the adults and nymphs suck the sap from the underside of the leaves which droop down, turn rusty, and are finally shed. The yield of the infested plants is affected adversely. Active from June to October on cotton. There may be about ten generations in a year.

Control: Spray with DDT 50% wettable at 0.05% strength.

2. *Aphis gossypii* Glov. (Aphididae; Homoptera). A minor pest on the underside of leaves or tips of branches. Both the adults and nymphs are yellowish green, they suck sap and devitalise the plants which show poor growth and in severe cases even wither. The pest secretes 'honey dew' on which sooty mould develops which interferes with photosynthesis. Active from August to November.

Control: Spray with (i) 50% wettable BHC at 0.15% strength (ii) Nicotine Sulphate at 1 : 800 or (iii) rosin soap 8 chk. in 20 seers of water.

3. White-fly, *Bemisia tabaci* Genn. (Aleurodidae; Homoptera). A major pest in hot and dry parts of the State. Alternative food plants are cauliflower, melon, 'bhindi', potatoes, and tomatoes, etc. Adults yellow, body lightly dusted with waxy powder. Both the adults and nymphs feed on the underside of leaves and devitalise the plants by sucking the sap. They also secrete 'honey dew' on which sooty mould develops which interferes with the photosynthetic activities of the leaves. The growth of the infested plant is arrested and the yield is considerably reduced. The pest is active practically throughout the year but the greatest damage to cotton is done during July-September.

Control: Spray with rosin compound or fish-oil soap or with DDT 50% wettable at 0.025% strength.

4. Red cotton bug, *Dysdercus cingulatus* Fb. (Pyrrhocoreidae; Heteroptera). A minor pest. Both the adults and nymphs desap the plants and also suck the sap from the buds and bolls. When the immature bolls are attacked they remain stunted, open badly, and yield poor cotton. Active during autumn and winter. Alternative food plants are 'bhindi' and 'gulkhera', etc.

Control: Dust with 5% BHC.

5. Dusky cotton bug, *Oxycaraenus loetus* Kirbey (Lygaeidae; Heteroptera). A minor pest. Both the adults and nymphs feed gregariously inside the bolls and suck juice from the seed which remain immature and light.

Control: Shake the top portion of plants in kerosinized water to destroy the pest.

(D) **Borers**

1. Spotted bollworms, *Earias insulana* Boisd. and *Earias fabia* F. (Noctuidae; Lepidoptera) (Fig. 8). Major pests in Amritsar, Jullundur, and Ferozepore districts. *E. insulana* outnumber *E. fabia* but the case is reverse in south-eastern districts of the State. Caterpillars are hairy and black with irregular whitish patches and cause the real damage. To start with, they bore into the top, tender, growing shoots, and cause them to wither. Thereafter, they bore into

the floral buds and bolls and spoil the lint. They also feed on the flower buds and pods of 'kangi booti' (*Abutilon indicum*), 'gulkhera' (*Althea rosea*), 'sunkukra' (*Hibiscus cannabinus*), 'saunchal' (*Malva parviflora*), 'kuchri' (*Malvastrum tricuspidatum*), and 'bhindi'. Active throughout the year but most abundant during July-September.

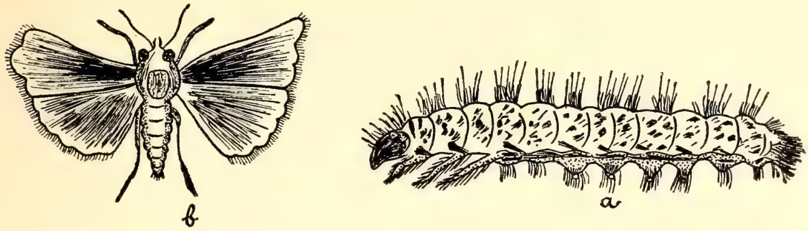


Fig. 8. Spotted bollworm, *Earias insulana* Boisd., (*a*) caterpillar × 3, (*b*) moth × 2.

Control: (i) Clean cultivation and destruction of alternative food plants, (ii) removal of cotton sticks about 2″ below the ground level after harvest to avoid ratooning of crop, (iii) to pick and destroy the infested buds and bolls and (iv) application of parasites.

2. Pink bollworm, *Platydera gossypiella* S. (Gelechidae; Lepidoptera) (Fig. 9). A major pest in south-eastern part of the State. The pink caterpillars bore into the bolls and feed on seed. Alternative food plants are 'bhindi', 'gulkhera', 'kangi booti', etc. Maximum damage is caused during October-November. The pest passes through 3 or 4 generations. The larva hibernates in double seeds.

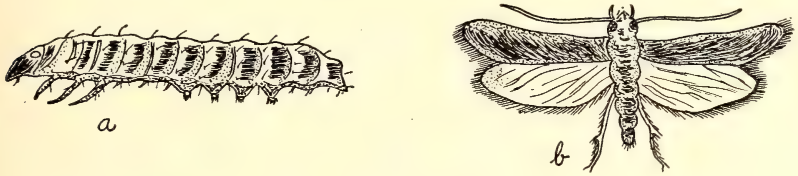


Fig. 9. Pink bollworm, *Platydera gossypiella* S., (*a*) larva × 2½, (*b*) moth × 2½.

Control: Fumigate cotton seed with Methyl Bromide.

3. Stem borer, *Sphenoptera gossypii* K. (Buprestidae; Coleoptera). A minor pest. The beetle is shining blue, the grubs bore into the stem near the ground level and cause a slight swelling. In serious cases the attacked plants may wither and die.

Control: Infested plants be removed and destroyed along with the grubs inside.

Sann Hemp, *Crotalaria juncea* Linn. Sown in the beginning of rainy season; ready for harvest in about four months.

(A) **Pest feeding on Leaves**

(*a*) Biting:

1. 'Lahni moth', *Utethesia pulchella* L. (Arctiidae; Lepidoptera). A sporadic pest in Gurdaspur district. The caterpillars feed on the

leaves and in severe cases may defoliate the plants completely. Active during May-July.

Control: Spray with BHC 50% wettable at 0.15% strength or dust with 5-7% BHC.

DHAINCHA (Border Crop), *Sesbania aegyptica* Pers.

1. Tobacco caterpillar, *Prodenia litura* F. (Noctuidae; Lepidoptera). A sporadic pest. The caterpillars feed on leaves and practically defoliate the plants. Active during summer.

Control: As above.

SANKUKRA (*Hibiscus cannabinus* Linn.). Sown in June or July and harvested in October-November.

1. Leaf hopper, *Empoasca* sp. A minor pest (*vide* cotton).

3. PESTS OF OILSEED CROPS

(i) CASTOR, *Ricinis communis* L. Sown in July-August and harvested in March-April.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Hairy caterpillar, *Euproctis lunata* Wlk. and *E. fraterna* M. (Lymantriidae; Lepidoptera). Major pests. Adult with orange-yellow wings with light wavy markings; eggs are laid in batches covered over with hairs on the underside of leaves. The caterpillars feed gregariously on the leaves. Pupation in the soil. Active during summer.

Control: (i) Hand picking of egg masses and caterpillars, (ii) spraying with wettable BHC or DDT at 0.1% or with lead arsenate.

2. Castor semi-looper, *Achaea janata* L. (Noctuidae; Lepidoptera) (Fig. 10). A major pest. The caterpillar, a blackish semi-looper is the destructive stage and feeds on the leaves and, in badly infested localities, the plants may be completely defoliated. Pupation in the soil. Active during summer.

Control: Dust with 5% BHC or spray with any stomach poison.

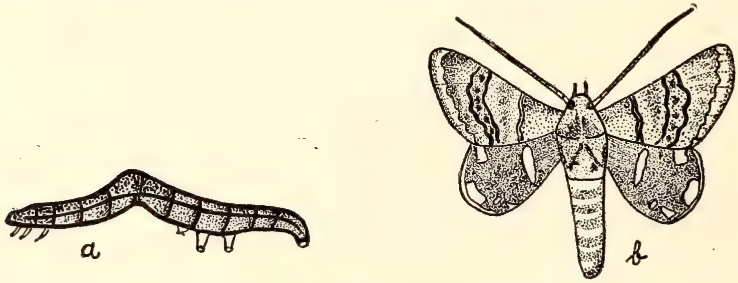


Fig. 10. Castor semi-looper, *Archaea janata* L., (*a*) semi-looper × $\frac{3}{4}$ (*b*) moth × $1\frac{1}{4}$.

(*b*) Sucking:

1. Castor white-fly, *Trialeurodes ricini* M. (Aleurodidae; Homoptera). A minor pest. The nymphs suck the sap from the underside of leaves, and on the 'honey dew' secreted a black fungus develops. Active during summer.

Control: (i) Spray the adults with DDT 0.025%, or (ii) the nymphs with rosin-soap 1 in 40 or rosin compound 1 : 6.

(ii) GROUNDNUT *Arachis hypogaea* L. Sown in June after the first rain or even a little earlier and harvested in October-November.

1. 'Kutra', *Amsacta moorei* Butt. (Arctiadae; Lepidoptera) (Fig. 11). A major pest in sandy soils which may destroy the entire crop when the incidence of attack is serious. Sporadic in outbreak.

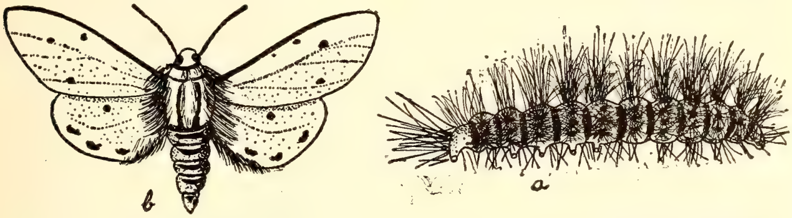


Fig. 11. Kutra, *Amsacta moorei* Butt. (*a*) caterpillar × ¾, (*b*) moth × 1.

Polyphagus feeder but shows marked preference to maize and sann hemp but it is equally destructive to 'chari', 'bajra', 'guara', and cotton. Infestation is rather serious in 'barani' areas with sandy or sandy loam soils as in Hoshiarpur, Ludhiana, Hissar, and Gurgaon districts.

Adult is stout, white, with black banded and dotted scarlet abdomen; they emerge with the first heavy shower of rain during monsoon. Destructive only in the larval stage and the stout hairy caterpillars usually move gregariously in thick bands and destroy the germinating or half-grown crops. Active from June to August. Pupation in the soil. Only one brood.

Control: (i) Heavy dusting with 10% BHC or Chlordane, (ii) trenching for migrating caterpillars when moving in bands, (iii) light traps for adults.

(iii) SARSON and TORIA (*Brassica* crops). Sown in September-October and harvested in March-April.

1. Aphis, *Myzus brassicae* (Aphididae; Homoptera). A major pest about the flowering time. The flowers wither and the pods are not well developed. The seed formation is poor. Also present on other alternative food plants as cabbage, cauliflower, etc. Both adults and nymphs are gregarious (*vide* cotton).

2. Painted bug, *Bagrada picta* F. (Pentatomidae; Heteroptera) (Fig. 12). A major pest also on cauliflowers, radish, and turnips, etc. throughout the State. Both adults and nymphs are destructive by sucking sap which cause the leaves to wither and dry up. The inflorescence is shed and seed produced is of poor quality. Active from August to April on different food plants with maximum damage

to turnips, radishes, and cauliflowers during October-November and to *Brassica* crops during March-April.

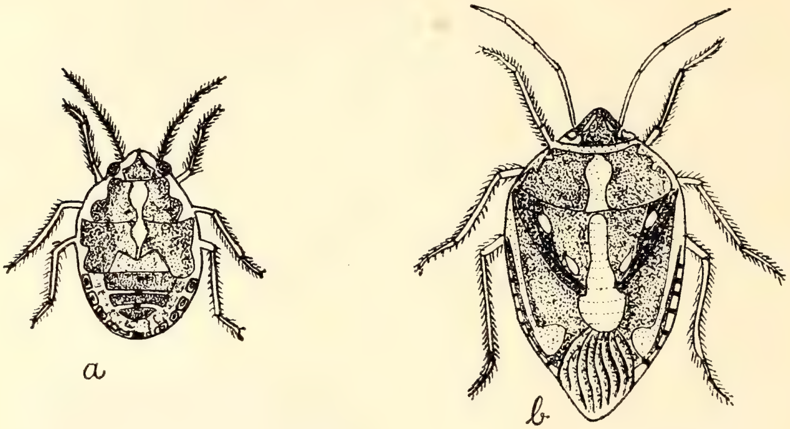


Fig. 12. Painted Bug, *Bagrada picta* F. (*a*) nymph × 6, (*b*) adult × 6.

Control: Dust with 5% BHC or Pyrodust 4.000, (ii) spray with wettable BHC 0.05%.

4. Pests of Tobacco, *Nicotiana tabacum* B.

Nursery sown in October-November; transplanted when the seedlings are 4-5 inches high, i.e. in about February. Ready for harvest by the end of May.

1. Cut worms, *Agrotis* sp. (Noctuidae; Lepidoptera). A serious pest of young seedlings in the nursery. The caterpillars cut the plants near ground level at night and feed on the leaves (*vide* gram).

2. Tobacco caterpillar, *Prodenia litura* F. (Noctuidae; Lepidoptera) (Fig. 13). A sporadic pest. The caterpillars feed on the leaves and practically defoliate the plants. Feed gregariously in early stages.

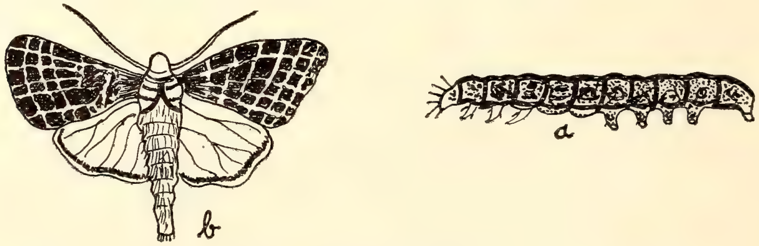


Fig. 13. Tobacco Caterpillar, *Prodenia litura* F., (*a*) caterpillar × 1, (*b*) moth × 1¼.

Active during summer. Full grown larva is greenish brown with dark markings. The adult is a dark moth with wavy white markings on the upper wings.

Control: Dust with 5-7% BHC or spray with BHC wettable 50% at 0.15% strength.

5. PESTS OF CEREAL CROPS

(i) RICE *Oryza sativa* L. Nursery sown during May-June; transplanted from July to middle of August. Harvested during October-November.

(A) Pests attacking Seedlings

1. Grasshopper, *Oxya* sp. (Acridiidae; Orthoptera). A major pest in Dasuya tehsil and in the 'bet' areas of Hoshiarpur district and near about Gurdaspur and Amritsar. It has assumed a major status after the Partition because the evacuee land remained neglected and the pest multiplied on wild grass. In serious cases nursery is practically wiped out and it has to be imported from other areas at high cost. The adults are green or yellowish green and hoppers are greenish. Both the adults and nymphs damage the seedlings and even the crop. Most active during June and July on nursery and in August-September on paddy and other crops. Only one brood.

Control: (i) Plough up *bunds* to destroy eggs and (ii) dust with 7-10% BHC to destroy all other stages.

(B) Pests feeding on Leaves

1. Grasshopper, *Hieroglyphus banian* Fb. (Acridiidae; Orthoptera) (Fig. 2). A major but sporadic pest in Hoshiarpur, Amritsar, Karnal, Ferozepure, and Gurgaon districts. Also attacks maize, 'bajra', 'jowar', and sugarcane. The adults have pale greenish patches and four black transverse furrows behind the neck; nymphs yellowish with reddish brown dots and patches.

Both adults and nymphs damage the crop by feeding on leaves and finally causing the ears to droop. Only one brood. Active from July to September but most destructive in about the middle of July (*vide* Sugarcane).

2. Spotted grasshopper, *Aularches miliaris* D. (Acridiidae; Orthoptera). A minor pest in the hilly tracts as Simla, Kulu, Kangra, and Hoshiarpur districts. Adults large, showy with green front wings and black abdomen with red transverse bands. Damage and control as above.

3. Rice hispa, *Hispa armigera* Olive. (Chrysomelidae; Coleoptera) (Fig. 14). A major pest in Kangra district. The adults and the grubs feed on leaves and green matter and cause withering of plants. Active during July and August.

Control: Dust with 5% BHC.

4. Unidentified beetle—A major pest in Ani tract of Kulu Valley where it causes heavy loss every year. The attacked plants wither without producing ears. Active during rainy season.

Control: Dust with 5-7% BHC.

5. Rice Skipper, *Chapra mathias* Fb. (Hesperidae; Lepidoptera). A minor pest. Occasionally green caterpillars are seen feeding on leaves. The adults are butterflies.

Control: Dust with 5-7% BHC or spray with wettable BHC if the attack is localised.

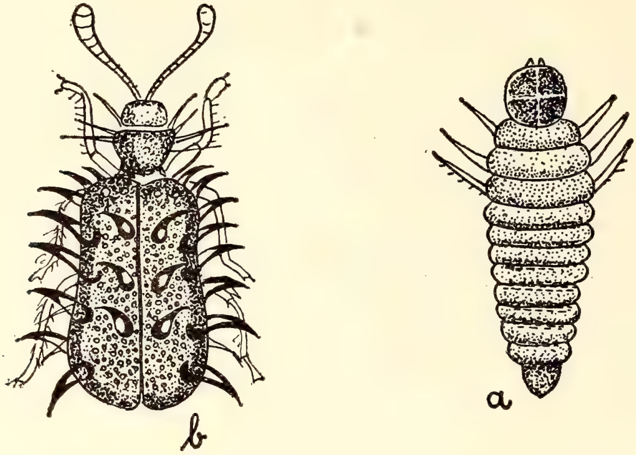


Fig. 14. Rice Hispa, *Hispa armigera* Oliv., (*a*) grub × 10, (*b*) adult × 8.

(C) **Borers**

1. Rice stem borer, *Schoenobius bipunctifer* Wlk. (Pyralidae; Lepidoptera) (Fig. 15). A major pest particularly in Gurdaspur

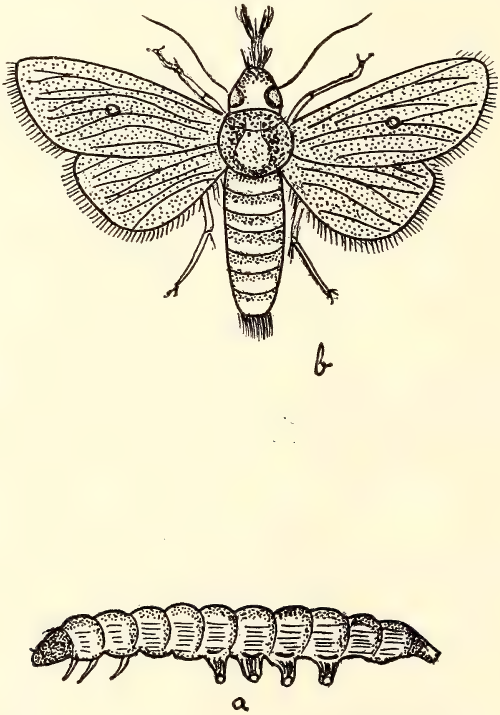


Fig 15. Stem Borer, *Schoenobius bipunctiter* Wlk., (*a*) caterpillar × 3, (*b*) moth × 2¼.

district. Adults yellow-white with a black spot in the centre of each front wing. Full grown caterpillars are dirty or greenish white. The caterpillars bore into the central shoot which is killed. The attack at the flowering stage results in keeping the ear-heads erect and empty as the grains are not developed. The pest may also attack the nursery plants. Active from May to October but the maximum damage is caused during August and September. There are 4-5 generations.

Control: (i) Destroy the stubble after harvest, (ii) in the nurseries egg masses be collected and destroyed and the seedlings showing 'dead heart' be discarded, (iii) light traps may give encouraging results against the adults.

2. Pink borer, *Sesamia inferens* Wlk. A minor pest (*vide* Sugarcane).

(D) **Pests feeding on ear-heads**

1. Rice bug, *Leptocorisa varicornis* Th. (Coreidae; Heteroptera) (Fig. 16). At times a major pest particularly in Karnal district. Alternative food plants are maize, jowar, and bajra. The adults are long, slender, and greenish whereas the nymphs are pale-green. Both the adults and nymphs suck the milky juice from the inflorescence and cause malformation of the grain in the ear-heads. Active during August and September.

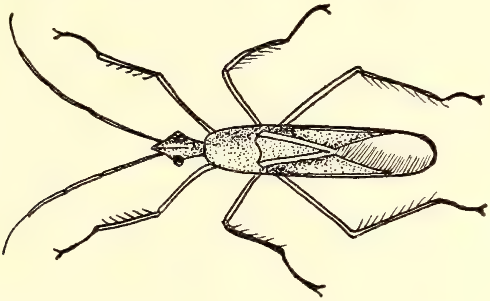


Fig. 16. Rice Bug, *Leptocorisa varicornis* Th.
(adult × 2)

Control: (i) Clipping of leaves bearing eggs and (ii) dusting with 5% BHC.

(ii) MAIZE *Zea mays* Linn. Sowing from March to July; harvested during September and October.

(A) **Pests attacking Roots**

1. White ants or Termites (*vide* Sugarcane).

(B) **Pests feeding on Leaves**

(*a*) Biting:

1. Kutra, *Amsacta moorei* Butt. (*vide* Groundnut).

2. Surface grasshopper, *Chrotogonus* sp. A minor pest of young crop (*vide* Cotton).

(*b*) Sucking:

1. Jassid, *Empoasca* sp. Occasionally a pest on young crop sown for fodder (*vide* Cotton).

2. Leaf hopper, *Pyrilla* sp. A minor pest (*vide* Sugarcane).

(C) **Borers**

1. Maize borer, *Chilo zonellus* Swin. (Pyralidae; Lepidoptera) (Fig. 17). A major pest of maize and 'jowar' in Amritsar, Karnal, Rohtak, Hissar, and Gurgaon districts. The adults are yellowish brown with a double row of black dots on the outer margin of each front wing. The destructive stage is the larva which bores into the stem, feeds on leaves and cobs, and also eats the ripening grain. Active from March to September with 4-5 generations.

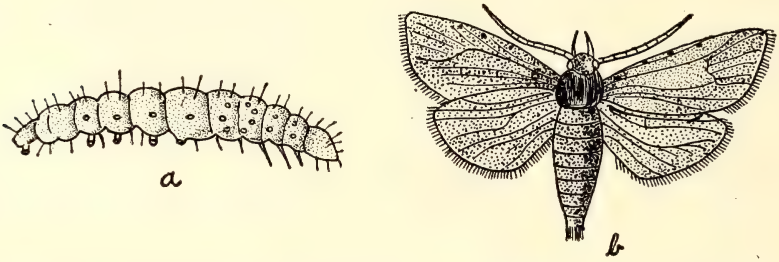


Fig. 17. Maize Borer, *Chilo zonellus* Swin., (*a*) caterpillar × 1$\frac{3}{5}$, (*b*) moth × 1$\frac{1}{2}$.

Control: (i) Remove stubble during the winter and destroy it, (ii) increase seed rate, and (iii) spray with 0.1% DDT, if necessary, a little before hatching of eggs when observed in large numbers.

2. Pink borer, *Sesamia inferens*. A minor pest particularly in Karnal district (vide Sugarcane).

(iii) JOWAR *Sorghum vulgare* Pers. Sown from May to July; harvested from September to November.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Grasshopper, *Hieroglyphus nigrorepletus* Bol. (Acridiidae; Orthoptera). A major pest in practically all the sub-mountain regions of the State. Both adults and nymphs are destructive particularly during July to September. Only one brood in a year.

Control: Dust with 10% BHC.

2. Kutra, *Amsacta moorei* Butl. A major pest (*vide* Groundnut).

3. Surface grasshopper, *Chrotogonus* sp. A minor pest (*vide* Cotton).

4. Grey weevil, *Myllocerus* sp. May be serious in sub-mountain regions and the adults are more destructive. Active from July to September (*vide* Cotton).

(*b*) Sucking:

1. Aphis, a minor pest (*vide* Cotton).

2. Mite, *Paratetranchus indicus* H. (Tetranychidae; Acarina). A major pest; imparts reddish or rusty appearance to leaves with profuse webbing.

Control: Dust with sulphur or spray with lime-sulphur wash.

(B) **Borers**

1. Jowar borer, *Chilo zonellus* Swin. (*vide* Maize).

(C) **Pests feeding on Grain**

1. Blister beetle, *Lytta tenuicollis* P. (Meloidae; Coleoptera). A minor pest. The adults feed on flowers and do not allow the seed to develop. Adults are large with conspicuous yellow stripes usually in large numbers. The destructive stage is the adult.

Control: (i) Near the fields burn fire to which the adults are attracted and will be killed, (ii) spray with DDT 0.2% wettable 50% powder, when present in clusters.

(iv) Bajra *Pennisetum typhoideum* Stapf and Hubbard. Sowing from May to July; harvested from September to November.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. 'Kutra', *Amsacta moorei* Butt. A major pest in Gurgaon and Hissar districts (*vide* Groundnut).

2. Lucerne caterpillar, *Laphygma exigua* Hb. A minor pest, active during July-August (*vide* Cotton).

(B) **Borers**

1. Maize borer, *Chilo zonellus* Swin. A minor pest (*vide* Maize).

(C) **Pests feeding on Grains**

1. Blister beetle. A minor pest in Gurgaon and Hissar districts (*vide* Jowar).

(v) Wheat *Triticum vulgare* Host. Sown in October-November; harvested in April-May.

(A) **Pests feeding on Roots**

1. White ants or Termites. Major pests of seedlings particularly in 'barani' tracts (*vide* Sugarcane).

(B) **Pests feeding on Leaves**

(*a*) Biting:

1. Army worm, *Cirphis unipuncta* N., (Noctuidae; Lepidoptera). A sporadic pest of the category of cutworms. The caterpillars feed on leaves and may completely defoliate the plants. It pupates in the soil.

Control: Dust with 5% BHC or baiting with poison-bran.

2. Surface grasshopper, *Chrotogonus* sp. A serious pest of germinating crop in 'bet' areas (*vide* Cotton).

(*b*) Sucking:

1. Aphis. A minor pest. Active during winter (*vide* Cotton).

(C) Borers

1. Wheat fly, *Atherigona indica* M. (Anthomyiidae; Diptera). Usually a minor pest, may become serious occasionally. The maggots bore into the young plants as a result of which the plants die. Active during January and February.

Control: The infested plants be removed and destroyed so that the maggots inside are also killed.

6. PESTS OF PULSE CROPS

(i) GRAM *Cicer arietinum* L. Sown in September-October; pod formation in February-March; harvested during March-April.

(A) Pests feeding on Leaves

1. Gram Cutworm (i) *Agrotis flamatra* Fab. (ii) *Agrotis ypsilon* Rott. (iii) *Euxoa* spp. (Noctuidae; Lepidoptera) (Fig. 18). The first species is the major pest of gram and vegetables in the State and particularly in the south-eastern districts. Adults are grey-brown with bean-shaped spot and two black wavy lines on each front wing. The caterpillar stage is destructive. They cut the plants at night just above or slightly below the soil. Quite a number of plants are thus destroyed, more than actually needed for food. Active during winter in plains and during summer in the hilly tracts. Three generations during the active period in the plains.

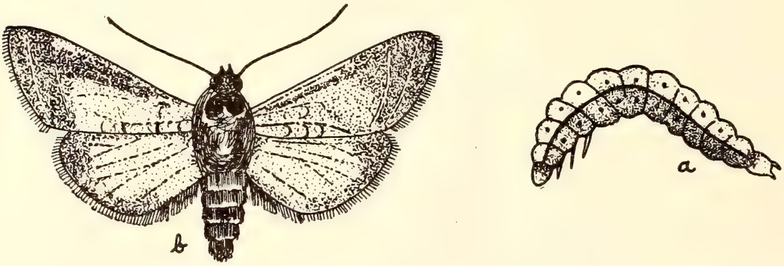


Fig. 18. Gram Cutworm, *Agrotis* sp., (*a*) caterpillar × $\frac{8}{9}$, (*b*) moth × 1.

Control: (i) Baiting with poisoned bran bait in the evening and (ii) dust near the base of the seedlings with 5% BHC.

(B) **Pod borer**

1. Gram caterpillar, *Heliothis obsoleta* F. (Noctuidae; Lepidoptera) (Fig. 19). A major pest. The caterpillars which are green with longitudinal greyish lines, destroy the seedlings but, when the plants are grown up, they bore into the pods also and feed on the ripening seed. This pest is cosmopolitan in feeding also infesting other crops like tomato and tobacco etc. Pupation takes place in earthen cocoons in the soil. Active from March to December with 7-8 generations in a year.

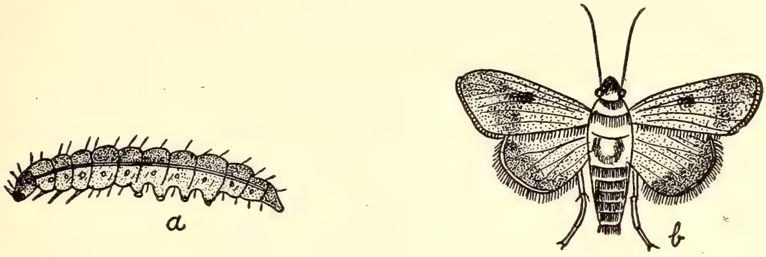


Fig. 19. Gram Caterpillar, *Heliothis obsoleta* F. (*a*) caterpillar ×, (*b*) moth × ¾.

Control: Dust with 5% BHC in the earlier stages of attack but as borers only hand picking is effective.

(ii) Mash *Phaseolus mungo* var. *radiatus* Prain. Sown in June-July; harvested from September-November.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Kutra, *Amsacta moorei* Butt. A major pest of 'mash' and 'moong' (*vide* Maize).

2. Mash hairy caterpillar. A major pest in Kangra district. The caterpillars are hairy and feed on leaves and completely defoliate the plants. Active during February-March.

Control: Spray with 0.2% BHC wettable or dust with 7% BHC.

(B) **Feeding on Flowers**

1. Blister beetles, *Mylabris* sp. (Meloidae; Coleoptera). A minor pest in Kangra district feeding on flowers during July-August (*vide* Jowar).

(iii) Peas *Pisum sativum* Linn. Sown in October-November; harvested in February onwards.

(A) **Pests feeding on Leaves**

1. Leaf miner, *Phytomyza atricornis* Meigen (Diptera). Usually a minor pest but occasionally may assume serious form particularly in Kangra district. The maggots mine the leaves and feed on the

chlorophyll forming irregular streaks. Also recorded from various plants including winter flowering plants. Active on peas during winter months.

Control: Spray with wettable BHC or DDT 0.05% strength.

2. Pea Thrip, *Thrips indicus* (Thripidae; Thysanoptera). A minor pest; the adults and nymphs suck sap from the leaves and devitalise the plants.

Control: (i) Spray with nicotine sulphate 1 : 800 or DDT wettable 0.05% strength.

7. PESTS OF FODDER CROPS

(i) LUCERNE *Medicago sativa* Linn. Sown in October; harvested by instalments and matures in May.

(A) Pests feeding on Leaves

(*a*) Biting:

1. Lucerne caterpillar, *Laphygma exigua* Hb. (Noctuidae; Lepidoptera) (Fig. 20). A major pest. Adult is yellowish brown. Also infests 'jowar', maize, gram, etc. The caterpillars web the leaves and skeletonise them. Active throughout the year.

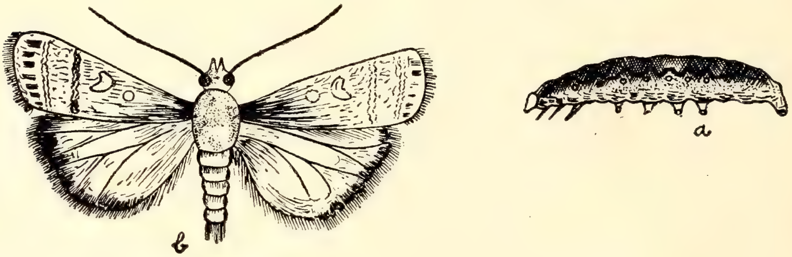


Fig. 20. Lucerne Caterpillar, *Laphygma exigua* Hb., (*a*) caterpillar × 1⅕, (*b*) moth × 1½.

Control: (i) Cut the crop and feed to cattle, (ii) spray with lead arsenate or DDT if it is not to be fed to cattle for at least 3 weeks.

2. Lucerne weevil, *Hypera variabilis* Hbst. (Curculionidae; Coleoptera). A major pest. It also infests other crops as 'senji', 'metha', 'maina', etc. The adult is oval, brown with a deep brown band on the middle of its back, and is the destructive stage. The leaves are eaten up and the crop gives a distorted appearance. Damage may be serious during January-March.

Control: As above.

(*b*) Sucking:

1. Aphis, *Aphis medicagenis* K. (Aphididae; Homoptera). A major pest but localised in distribution, (*vide* Cotton). Biological control by *Coccinella septumpunctata* predator is also very effective.

(ii) GUARA *Gyamopsis psoralioides* DC. Sown at the commencement of rains and the crop is ready in about two months.

1. Leaf hopper (Jassidae) is occasionally a pest but never serious (*vide* Cotton).

JOWAR *Sorghum vulgare* Pers. (*vide* Cereal Crops).

(iii) OATS *Avena sativa* L. Sown in October; harvested in April. Only *Pyrilla* sp. is a minor pest (*vide* Sugarcane).

(iv) TURNIP *Brassica rapa* L. Sown in September-October; fodder is available during December to February.

(A) Pests feeding on Leaves

1. Mustard saw fly, *Athalia proxima* K. (Tenthredinidae; Hymenoptera). A major pest of cruciferous crops. Adults are orange-yellow with wings, head, and legs smoky. The grubs are black which feed on the underside of leaves and cause the characteristic damage by cutting holes. With the slightest touch they curl up and fall down on the ground. The damage is particularly serious to the germinating and young crops which are practically skeletonised. At times the seedlings are completely destroyed. Active during autumn and winter.

Control: (i) Hand picking of larvae, (ii) dusting with 5% BHC and (iii) spraying with lead arsenate.

2. Painted bug, *Bagrada picta* F. A major pest of young crop (*vide* Sarson and Toria).

(v) JAPAN RAPE *Brassica napus* L. Sown in September-October; ready as fodder during December-February.

(A) Pests feeding on Leaves

1. Cabbage butterfly, *Pieris brassica* L. (Pieridae; Lepidoptera) (Fig. 21). A major pest of cabbage, cauliflower, etc., both in the hills and plains. Adults are conspicuously white with black markings on the forewings. The caterpillars are greenish blue with yellow lines on the back and sides, and feed gregariously. It is the destructive stage which skeletonises the leaves and in severe cases defoliates the entire plants. The inflorescence and the tender pods are also eaten up. Active from May to October in the hills, and during winter months in the plains. A generation in the plains may take 4-6 weeks.

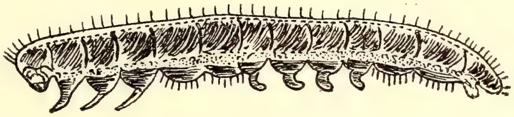


Fig. 21. Cabbage Caterpillar, *Pieris brassica* L. × 2.

Control: (i) Collection of adults by hand nets, (ii) hand picking of larvae and killing them in kerosinized water and (iii) spray with 0.05% DDT wettable.

2. Painted bug, *Bagrada picta* F. A major pest (*vide* Sarson and Toria.)

8. PESTS OF VEGETABLES

(i) CUCURBITS. Usually sown from March to June and again in November; vegetables available in the market from March to November.

(A) Pests feeding on Leaves

(*a*) Biting:

1. Red pumpkin beetle, *Aulacophora foveicollis* Lucas (Chrysomelidae; Coleoptera) (Fig. 21). A very destructive pest of gourd, pumpkin, 'tinda', cucumber, and melons, throughout the Panjab. The adults, with shining brown or red forewings, are most destructive as they feed on leaves and bite holes. Active from March to September but inflict serious damage to seedlings during March-April. The grubs also damage by boring into the roots and stems and also the fruits on the soil. In severe cases of attack the sowings have to be repeated. Immature stages live in the soil.

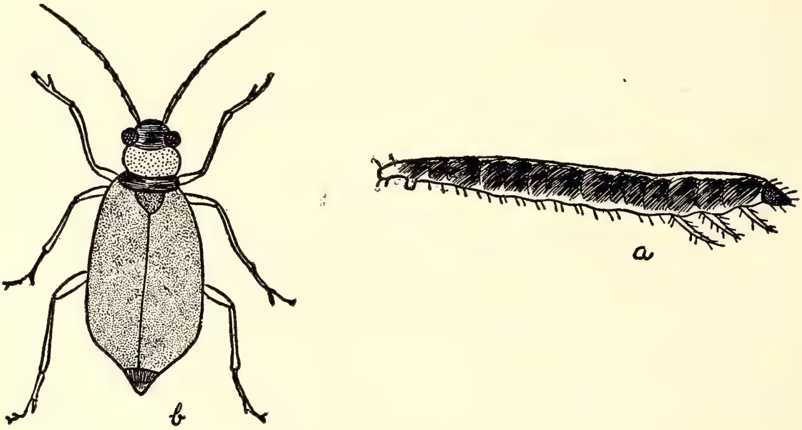


Fig. 22. Red Pumpkin Beetle, *Aulacophora foveicollis* Lucas, (*a*) larva × 4½, (*b*) adult × 6.

Control: Dust the seedlings with (i) sodium fluosilicate and ashes 1 : 8, (ii) 2.5% BHC or (iii) spray with lead arsenate 2 lb. in 60 gallons of water.

2. Blue beetle, *Aulacophora atripennis* Fab. (Chrysomelidae; Coleoptera). A minor pest in the plains but may cause considerable damage to 'ghia tori' in the lower hills. Dark blue beetles feed on the leaves and in severe cases the leaves are studded with holes as a result of which they may dry up. Active during summer, cause severe damage during August-September.

Control: As above.

3. Cucurbit 'Hadda', *Epilachna dumerili* Muls. (Coccinellidae; Coleoptera) (Fig. 23). A minor pest. Beetles are of light copper colour with six black dots on each forewing. Both the adults and grubs are destructive and feed on the underside of leaves on the epidermal tissue. Active from April to September. Serious damage is observed on melons in the beginning of its active season or on gourd towards the end of the season.

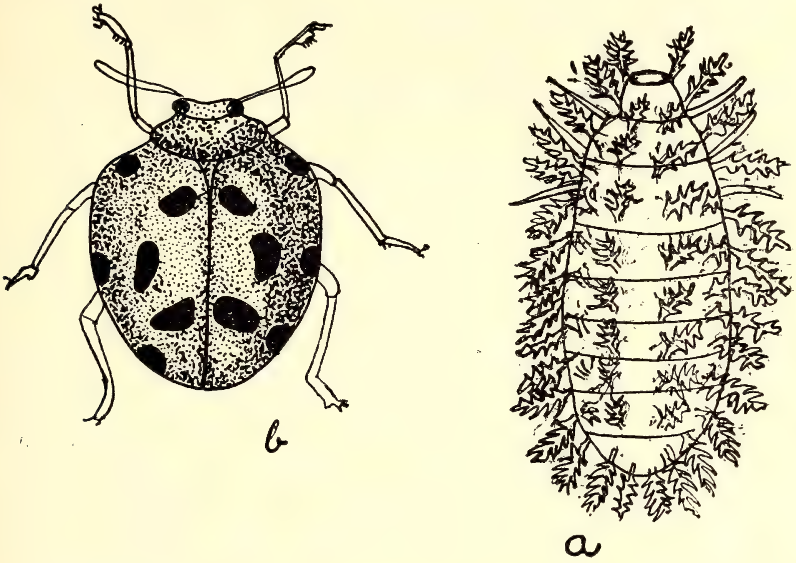


Fig. 23. Brinjal Hadda, *Epilachna* sp., (*a*) grub ×5, (*b*) adult ×4½.

Control: (i) Dust with sodium fluosilicate and ashes at 1 : 8 or (ii) spray with DDT 50% wettable at 0.05% strength or with lead arsenate.

(*b*) Sucking:

1. Kaddu bug, *Aspongopus janus* Fabr. and *A. brunneus* Thunb. (Pentatomidae; Heteroptera). Minor pests. The adults are reddish brown, front wings membranous and legs black. Both adults and nymphs suck sap from the leaves. Active from March to November.

Control: Spray with rosin soap at 2.5% strength.

2. Aphis, *Siphocoryne indobrassica* Dass (Aphididae; Homoptera). A minor pest. Occasionally serious on gourd, water melons, and 'tinds', etc. in early stages. The insects suck the sap from the leaves. The presence of 'honey dew' secreted by the insects and the subsequent growth of black fungus imparts a 'sooty' appearance to the infested leaves. Active during summer.

Control: Spray with rosin soap at 2.5% strength or with nicotine sulphate at 1 : 800.

3. Vegetable mite, *Tetranychus cucurbitae* R. & S. (Tetranychidae; Acarina). A serious pest of 'tinda' in the plains, although infests

variety of plants as pumpkin, brinjal 'ghia tori', tomatoes, pulses, peas, hollyhock, etc. It sucks the leaf sap and the attacked leaves lose chlorophyll. The infested foliage is covered with profuse web and the leaves gradually dry up and fall. Active from March to June and again during September-October during which periods many generations may be passed.

Control: Dusting with sulphur or spraying with lime-sulphur.

(B) Pests on Flowers

1. Blister beetle, *Mylabris* sp. (Meloidae; Coleoptera). A minor pest (*vide* 'Jowar').

2. Unidentified caterpillar, *Heliothes* sp. (Noctuidae; Lepidoptera). A minor pest, feeds inside the flowers, met with particularly at Palampur (*vide* Gram).

(C) Pests on Fruits

1. Fruit flies, *Dacus cucurbitae* Cog. and *Dacus zonatus* S. (Trypaneidae; Diptera) (Fig. 24). Major pests of melons, 'karela', 'ghia tori', and 'chappan kadu'. The eggs are laid below the skin of the fruit, the maggots bore inside, feed on the pulp, and cause the fruits to rot, and consequently render them unfit for human consumption. Active from May to September. Pupation in the soil.

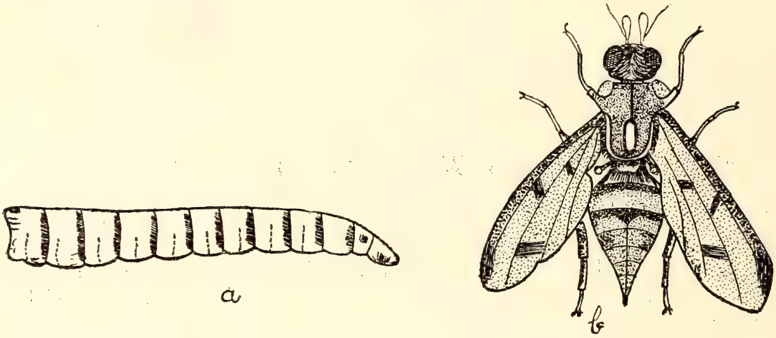


Fig. 24. Fruit Fly, *Dacus cucurbitae* Cog., (*a*) maggot ×4, (*b*) adult ×4

Control: The damaged fruits be destroyed and the adult flies be trapped by baiting. The infested fields be ploughed well after harvest to destroy the pupae.

(ii) BRINJAL *Solanum melongena* L. Grown thrice a year in the plains, (i) 'Sirhindi' variety is transplanted before the end of April; (ii) large round purple and large long purple are transplanted in August-September and (iii) round small purple is transplanted in February. Fruits are available practically throughout the year.

(A) Pests feeding on Leaves

(*a*) Biting:

1. 'Hadda,' *Epilachna vigintictopunctata* F. and *Epilachna dodecastigma* M. (Coccinellidae; Coleoptera). Very serious pests

practically all over the State, in the plains. Alternative food plants are potatoes and tomatoes etc. The adults are reddish in both the species, and bear 7-14 black dots on the front wings in the case of former and 6 dots in the latter species. The grubs are light yellow and hairy. Both the adults and the grubs are destructive and feed on the underside of leaves giving them a lace-like and ragged appearance. Active from April to October causing maximum damage during May and June. There may be 4 generations.

Control: Spray with DDT wettable powder 50% at 0.05% strength.

2. Leaf roller, *Eublemma olivacea* Wlk. (Noctuidae; Lepidoptera). A minor pest in the plains. The larvae roll up leaves and feed inside. The rolled portion dries up. Active from May to September.

Control: (i) Hand pick and destroy the rolled up leaves along with the caterpillars, (ii) spray with lead arsenate if fruits are not formed or after they are plucked.

3. Hairy caterpillar (unidentified). Occasionally a serious pest. The larvae feed on leaves and may entirely defoliate the plants. Active from May to August.

Control: Spray with DDT wettable 50% at 0.15% strength.

(*b*) Sucking:

1. Jassid, *Empoasca devastans* Dist. Usually a minor pest, but sometimes may be quite serious during October-December (*vide* Cotton).

2. Tingid bug, *Urentius sentis* Dist. (Tingidae; Heteroptera). Very serious pest exclusively on brinjals. Adults with straw coloured body above, the lower surface black. Both the adults and nymphs suck sap from the leaves which turn yellow, wither, and finally drop. With severe attack all the leaves may shed. Active from April to October, but the maximum damage is done during August and September. The crop planted in autumn suffers the most. There may be a number of generations during the year.

Control: Dust with 5%BHC or spray with fish-oil soap 2.5% or nicotine sulphate 1 : 800.

(B) **Borers**

1. Fruit borer, *Leucinodes orbanalis* Guen. (Pyralidae; Lepidoptera). A major pest practically all over the State. The pink larvae bore into the top shoots or the flower buds which do not set fruit. These also bore into the fruits and render them unmarketable. Most serious damage is done to fruits and a single fruit may harbour even half a dozen caterpillars. Active from April to October.

Control: Repeated spray with 0.15% DDT wettable at fortnightly intervals.

2. Stem borer, *Euzophera perticella* Rag. (Pyralidae; Lepidoptera). A minor pest, the caterpillars bore into the stem and may kill the young plants. In grown up plants the growth is retarded.

Control: As above.

(iii) 'BHINDI' *Hibiscus esculentus* L. Planted from February to July; fruits available from March to October.

(A) **Pests on seedlings**

1. Cut worm, *Agrotis* sp.(Noctuidae; Lepidoptera). A minor pest of germinating crop which the caterpillars cut quite close to the soil.

Control: (i) Dusting BHC 5% on the infested area but near the plants, (ii) baiting with poisoned bran bait.

(B) **Pests feeding on Leaves**

(*a*) Biting:

1. Black leaf beetle *Podagria* sp. (unidentified) (Coleoptera). Quite a serious pest in Kangra Valley. The adults feed on the epidermal tissue of leaves, branches and on flower buds. Active from June to September.

Control: Spray with DDT 0.15% wettable or lead arsenate.

2. Leaf roller, *Sylepta derogata* F. A minor pest (*vide* Cotton).

3. Semi-looper, *Acontia* sp. A minor pest (*vide* Cotton).

(*b*) Sucking:

1. Jassid, *Empoasca devastans* Dist. (Jassidae; Homoptera). A major pest in Amritsar, Jullundur, Ludhiana, Ferozepur, and Hissar districts. The attacked leaves get crumpled and finally dry up and fall. This affects the fruit formation adversely (*vide* Cotton).

2. Red mite, *Tetranychus tetericus* L. (Tetranychidae; Acarina). A major pest of 'bhindi', 'tinda', 'sem', 'ghia tori', and sweet potatoes. It is often met with *Tetranychus cucurbitae*. Both the adults and nymphs are reddish and suck the sap from leaves, spin profuse webbing on the leaves and stems, and the attacked plants ultimately die. Active from April onwards, but causes severe damage during July and disappears completely by February.

Control: Dusting the crop with sulphur or spraying with lime sulphur.

3. Red cotton bug, *Dysdercus cingulatus* Fb. (Pyrrhocoridae; Heteroptera). A minor pest (*vide* Cotton).

(C) **Pests on Flowers**

1. Blister beetle, *Mylabris phalerata*; *Mylabris tiplensis* P. (Meloidae; Coleoptera). Minor pests but often become serious in Kangra Valley. The adults feed on flowers and flower buds, as a result of which the plants do not bear any fruit. Active from August to October (*vide* Jowar)

(D) **Pests on Fruits**

1. Spotted bollworms, *Earias* spp. Quite a serious pest (*vide* Cotton).

2. Dusky cotton bug, *Oxycaraenus loetus* Khy. A minor pest of cracked fruits (*vide* Cotton).

(iv) SWEET POTATO *Ipomoea batata* Poir. Planted during March-April; harvested during November.

(*a*) Biting:

1. Grasshoppers (Acridiidae; Orthoptera). Various short horned grasshoppers feed on leaves during summer, but they never assume a serious form.

Control: Dusting with 5-7% BHC.

(v) 'PALAK' *Beta bengalensis* L. Sown from the middle of June to November in plains and March to May in hills.

(*a*) Biting:

1. Palak beetle, *Haltica caerulescens* Bar. (Coleoptera). Fairly serious pest in Kangra Valley. Both the adults and grubs bite holes in the leaves. Active from March-May and again during September-October.

Control: Hand picking.

(vi) POTATO *Solanum tuberosum* L. Planted in September and January; harvested in January and May.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Potato caterpillar (unidentified) (Lepidoptera). A minor pest but occasionally it assumes a serious status in Kangra Valley before harvest. The caterpillars feed on leaves and the crop suffers considerably. Active from February-April.

Control: Spray with lead arsenate.

(*b*) Sucking:

1. Green potato bug, *Nezara viridula* L. (Pentatomidae; Heteroptera). A minor pest, sucks sap from foliage. Usually present throughout the crop season.

Control: Spray with rosin soap at 2.5% strength.

2. Potato jassid, *Empoasca solanifolia* Pr., *Empoasca punjabensis* Pr., and *Empoasca devastans* Dist. (*vide* Bhindi and Cotton).

(B) **Pests infesting tubers**

1. Potato tuber moth, *Gnorimoschema operculella* Zell. (Gelechidae; Lepidoptera) (Fig. 25). A minor pest of potato leaves during

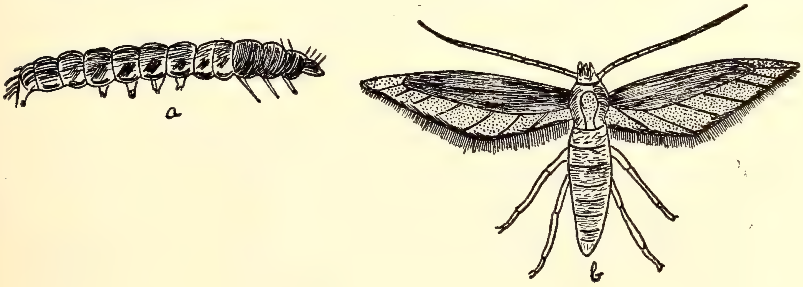


Fig. 25. Potato Tuber Moth, *Gnorimoschema operculella* Zell., (*a*) caterpillar ×5, (*b*) moth ×5.

February-March, but major pest of stored potatoes in Kangra Valley. The adults are greyish brown moths splashed with dark brown. The dirty white caterpillars first spoil the tuber eyes and then bore into the tubers thus rendering them unfit for seed as well as for consumption. Active from May to October in the stores.

Control: (i) Spray the plants with 0.05% DDT wettable to protect the leaves, (ii) protect the potatoes under layer of sand and (iii) dust seed potatoes with BHC-Gammaxine D024 or DDT 33 A.

(vii) ONION *Allium cepa* L. Transplanted in January; harvested in May.

(A) **Pests feeding on Leaves**

(*a*) Sucking:

1. Thrips, *Thrips tabaci* L. (Thripidae; Thysanoptera) (Fig. 26). A major pest all over the State. Adults are yellowish brown with long narrow wings fringed with long hairs along the margins. Both the adults and nymphs desap the leaves which become curled, wrinkled, and twisted, and may finally die, which affects the yield adversely. The pest remains active throughout the year on various vegetables but does the greatest damage to onions during April. One generation is completed in 2-3 weeks.

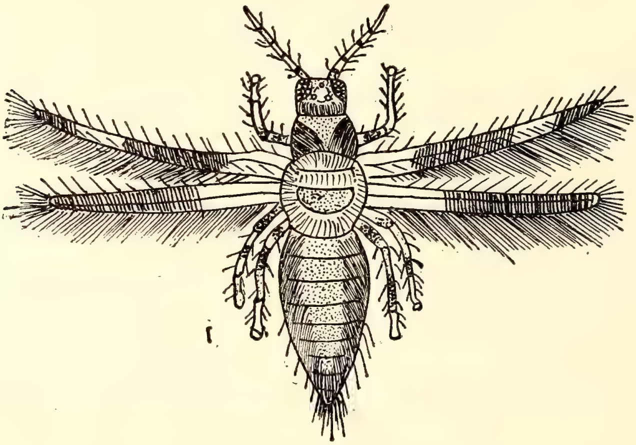


Fig. 26. Onion Thrips, *Thrips tabaci* L. (Adult × 25)

Control: (i) Spray the crop with nicotine sulphate 1: 1,000 parts of water or tobacco decoction 1: 5, (ii) with BHC wettable at 0.1% or (iii) dust with 5% BHC.

(viii) TOMATO *Lycopersicum esculentum* Miller. There are three crops a year in the plains. First crop transplanted in June-July, second in August-October, and the third in February. The fruits are available throughout the year.

(A) Pests feeding on Leaves

(*a*) Biting:

1. 'Hadda', *Epilachna* sp. A minor pest but occasionally causes serious damage to the young crop during September-October (*vide* Brinjal).

(*b*) Sucking:

1. Jassid, *Empoasca punjabensis* or *E. devastans* Dist. A minor pest (*vide* Cotton and Potato).

2. White-fly, *Bemisia tabaci* Genn. (Aleurodidae; Homoptera). A major pest as a carrier of virus disease. The affected plants show crumpling of leaves and smalling of shoots (*vide* Cotton).

(B) Borers

1. Tomato borer, *Heliothis obsoleta* F. (Noctuidae; Lepidoptera). A minor pest but at times may become serious in the lower hills and submountain regions. The caterpillars bore into the raw tomatoes and render the fruit unmarketable (*vide* Gram).

Control: Spray with 0.05% DDT wettable.

(ix) CABBAGE AND CAULIFLOWER. Sown or transplanted from August onwards and harvested from October to April.

(A) Pests feeding on Leaves

(*a*) Biting:

1. Cabbage butterfly, *Pieris brassica* L. (Pieridae; Lepidoptera) (Fig. 21). A major pest of cabbage, cauliflower, knol kohl, 'sarson', and 'raya', both in the hills and the plains. It proves a limiting factor in raising knol kohl seed in the Kangra Valley. Adults are conspicuously white with black markings on the forewings and the caterpillars greenish blue with yellow lines on the back and side. The caterpillars feed gregariously in the early stages. They skeletonize the leaves and may defoliate the entire plants. The flowers or tender pods are also eaten and destroyed, often the insects bore into the cabbage heads. Active from May to October in the hills and during winter months in the plains. One generation may be completed in 4-6 weeks in the plains.

Control: (i) Hand pick the adults and the eggs and larval clusters and kill them in kerosinized water, (ii) spray with 0.05% DDT wettable or Pyrocolloid 1 in 800.

2. Diamond back moth, *Plutella maculipennis* Curtis (Plutellidae; Lepidoptera). A minor pest of cabbage, cauliflower, and 'Japan sarson'. The adults are brownish or grey with conspicuous white spots on the front wing. The green caterpillars bite holes in the leaves on which they pupate in a thin silken cocoon. Active during winter. One generation may be completed in 4-5 weeks.

Control: Spray with 0.05% or 0.1% DDT wettable.

3. Cabbage semi-looper, *Plusia orichalcia* Fb. and *Plusia nigrisigna* Wlk. (Noctuidae; Lepidoptera). Minor pests of cabbage and

cauliflower etc. At times may assume serious proportions. May also infest other crops as turnips, radishes, and some *Brassica* crops. The adult moths are dirty brown with golden splash on the forewings or white and blackish markings. The caterpillars are green with longitudinal lines; feed on leaves and bite holes. Active during winter months.

Control: Spray with 0.1% DDT wettable or lead arsenate before the heads are formed.

4. Mustard saw fly, *Athalia proxima* K. (Tenthredinidae; Hymenoptera) (Fig. 27). A major pest of various cruciferous crops. Adults are orange-yellow with their wings, head, antennae, and legs smoky. The black grubs feed on the underside of leaves and bite holes, they curl up and fall down with the slightest touch. The damage is particularly serious to germinating and young radish and turnip plants by biting holes or skeletonising the leaves. Often the seedlings are entirely destroyed. Active from the end of September to January.

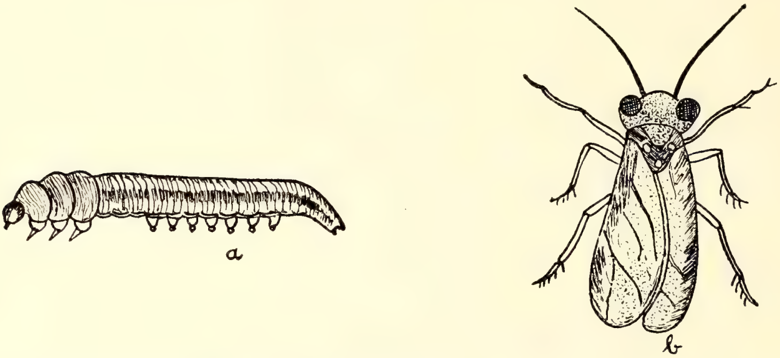


Fig. 27. Mustard Saw-fly, *Athalia proxima* K., (*a*) larva ×4½, (*b*) adult ×4½.

Control: Dust with Pyrodust 4,000 or BHC 5%.

5. Tobacco caterpillar; *Prodenia litura* F. A sporadic pest, particularly serious to early cauliflowers, i.e. during September-October, in the plains (*vide* 'Dhaincha').

6. Grasshoppers (Acridiidae; Orthoptera). Minor pests. Surface grasshoppers and other short horned grasshoppers feed on the leaves during September-October.

Control: Poison baiting or dusting with BHC 5-7%.

(*b*) Sucking:

1. Painted bug, *Bagrada picta* F. (Pentatomidae; Heteroptera). A major pest of radish, turnips, cauliflower, cabbage, knol kohl, etc. in all the vegetable growing tracts of the State. Both the adults and nymphs are conspicuously coloured with black, orange and yellow coloration, and cause damage by sucking the sap as a result of which the leaves wither and dry up, the flowers wither and drop down, and the pods produce little seed of very inferior quality. Active from

August to April on various vegetables, and does the greatest damage to radish and turnip during October and November by feeding on leaves, and to the inflorescence of various *Brassica* crops during March-April.
Control: Dust with Pyrodust 4,000 or BHC 5%.

2. *Eurydema* sp. and *Dolichoris* sp. (Pentatomidae; Heteroptera). Minor pests. These bugs occur along with the painted bug in the Kangra Valley. Therefore same control measures.

3. Cabbage aphis, *Siphocoryne indorassica* Dass (Aphididae; Homoptera). A major pest of various cruciferous plants. The insect is greenish or yellowish green in colour. It sucks the sap from the infested leaves, inflorescence, and pods and, because of its huge population it devitalizes the plant. As a result of its attack the flowers wither, the pods do not set properly; thus the yield of the crop is considerably lowered. Active from December to May, but the greatest damage is done during March-May. Its severity in Kulu Valley becomes a limiting factor in raising the seed of cabbages and knol kohls etc.
Control: Spray with (i) tobacco decoction, (ii) fish-oil soap 2.5% or (iii) 0.1% BHC wettable.

White-fly, *Bemisia tabaci* Genn. A minor pest of cauliflower, turnips and radishes (*vide* Cotton).

(x) CHILLIES *Capsicum annum* Linn. In the plains it is sown in March-April; chillies are ready for picking during September to November.

1. White ant, *Termes* sp. (Termitidae; Isoptera). Major pests in some parts of the State. It attacks the underground portion of the plant as a result of which the plants wither and ultimately dry up (*vide* Sugarcane).

2. White-fly, *Bemisia tabaci* Genn. A major pest as a vector of virus disease. The affected plants have crumpling of leaves and smalling of shoots (*vide* Cotton).

(xi) WATERNUT *Trapa bispinosa* Roxb. The crop is available in ponds during July-October.

1. 'Singhara' beetle, *Galerucella singhara* Lefroy. (Coleoptera). A major pest in Ambala, Gurgaon, and Gurdaspur districts. The adults feed on leaves and completely destroy them. It is destructive during July and August. Eggs are laid on the leaves.
Control: Dust with 5% BHC.

9. PESTS OF FRUIT AND FRUIT TREES

(i) APPLE *Pyrus malus* L.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Tent caterpillar, *Malacosoma indica* Wlk. (Lepidoptera). A sporadic pest in the Simla Hills. Besides apples, it also attacks wild and cultivated pears and 'shaigal'. The caterpillars live and feed

gregariously in sheltered places on the plant. Full grown caterpillar has a longitudinal central grey line with two crimson colour dotted lines on either side of it. The nest or the tent, as it is called, varies in sizes according to the age of the caterpillar. As many as 25 such tents may be found on a single tree. The caterpillars spend the day in these tents and feed on leaves at night and in severe cases of infestation, the entire tree may be defoliated. In the absence of leaves, the caterpillars feed on tender bark. Active from March to June. Only one generation in a year.

Control: (i) The tents should be hand picked and burnt with caterpillars, (ii) spray with lead arsenate 1 : 100 or with BHC wettable 0.15%.

2. Apple hairy caterpillar, *Lymantria obfuscata* Wlk. (Lymantridae, Lepidoptera). A sporadic pest in Simla, Kotgarh, Kot khai, and Ani (Kulu Valley). The caterpillars, which are brown and clothed with tufts of hair, are gregarious and nocturnal in habit. As such they hide themselves in loose soil round about the base of the tree during day and come out at night, climb the plants, and feed on the leaves till dawn. The attacked plants may be completely defoliated, and do not bear any fruit. Active from March to July. There is only one generation in a year.

Control: (i) Spray clusters of caterpillars with BHC emulsion when migrating. (ii) spray plants with lead arsenate 1 : 100.

3. Leaf beetle, *Mimastra cyanea* Hope (Curculionidae; Coleoptera). A major pest, of apples, peaches and plums in the Simla Hills and Kangra Valley. The adults feed on leaves and in severe cases all the foliage may be eaten. The insect is active from May to August.

Control: Spray with lead arsenate 1 : 100 or DDT 0.2%.

(*b*) Sucking:

1. San Jose scale, *Quadraspidiotus perniciosus* Comstock (Coccidae; Homoptera) (Fig. 28). A most destructive pest in the Kulu valley and Simla hills. It also attacks plums, peaches, pears, cherry, apricot, almond, and roses. The female scale is round and

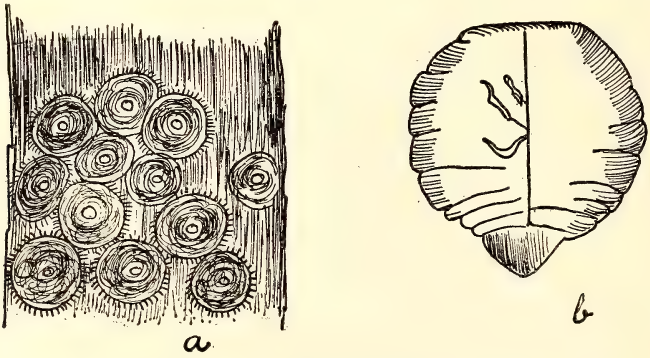


Fig. 28. San Jose Scale, *Quadraspidiotus perniciosus* Com., (*a*) scales × 2-4, (*b*) adult ♀ × 13.

flattened with a nipple in the centre which is surrounded by a depression. Male scale is elongated with its nipple on one side. The insect sucks sap from the twigs of growing plants and, as a result of quick multiplication, the plants are unable to withstand the drain and consequently may die. Dispersal is through nursery stocks, scion and graft, birds and flying foxes. Active from April to December and passes through 4-5 generations. Apple fruits are also infested.

Control: Spray with Diesel-oil emulsion and the 'crawlers' with DDT 0.05% wettable.

2. Woolly aphis, *Eriosoma lanigerum* Hausm. (Aphididae, Homoptera) (Fig. 29). A very destructive pest in the Simla hills and the Kulu Valley. The attacked plant shows whitish, cottony patches or masses on the stems and branches, each of which is covered with white waxy threads under which the insect lies. It has the habit of partial seasonal migration and some of the aerial forms migrate to the roots in December while those from roots to the aerial parts in May. The pest feeds on plant juice sucking from the stems, branches, twigs, and roots. The attacked plant with its deformed limbs and pale yellow leaves presents sickly appearance. Besides, big knots or gall-like swellings appear on the affected parts. These swelling on the roots always prove serious. The plants become sickly, remain stunted in growth, and yield less fruit. Heavily infested young plants often die. Active throughout the year (reduced activity in winter). But the greatest damage is done during April-May and October-November. At Simla as many as twelve generations have been recorded in the laboratory.

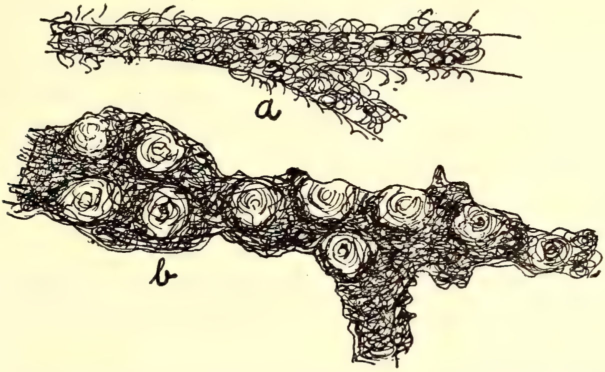


Fig. 29. Woolly Aphis, *Eriosoma lanigerum* Hausm., (*a*) infested apple shoot, (*b*) infested apple root. (Diagrammatic).

Control: (i) Biological control by introducing its parasite *Aphalinus mali* from the Entomologist, Panjab, (ii) spray with nicotine sulphate and fish-oil soap and (iii) mixing of BHC with soil at the time of migration of the pest.

(B) **Borers**

1. Apple tree borer, *Apriona cinerae* Chev. (Coleoptera). Recently achieved prominence in the Simla hills causing considerable damage to

apple plantation. The larvae bore into the branches and trunk of young plants and make tunnels in the interior. The attacked plants often die. Active during spring and summer.

Control: Petrol or potassium cyanide fumigation.

2. Apple stem borer, *Aeolesthes holosericea* F. (Coleoptera). A fairly serious pest in Simla hills and Kulu Valley attacking the apple and cherry plants. The larvae bore into the trunk and make zig-zag tunnels. The attacked tree can be recognized by the presence of heaps of chewed up frass mixed with excreta on the ground underneath the tree. Seriously infested plant gives sickly appearance and bears little fruit. If left neglected, the plant may die within a couple of years. A single generation may be completed in 2-3 years.

Control: Petrol or potassium cyanide fumigation.

3. Root borer (unidentified), (Coleoptera). Recently it has achieved prominence in Kotgarh. The grubs bore into the roots and the attacked plants succumb to the injury. Usually infests trees planted in the sandy soil.

Control: Mixing BHC in the soil or soil fumigant, as Paradichlorobenzine, proves effective.

(ii) APRICOT *Prunus bokhariensis* Royle.

1. Leaf cutworm, *Parasa* sp. (Lepidoptera). A minor pest in the Simla hills. The caterpillars feed on the leaves. Active from June to October.

2. Fruit borer, *Cocoecia* sp. (Lepidoptera). A minor pest of cultivated varieties but serious on wild varieties in the Simla hills. The caterpillars bore into the fruit and feed inside. Active during summer.

Control: Spray young fruits with 0.05-0.1% DDT wettable.

(iii) PEACHES AND PLUMS, *Prunus persica* L., *Prunus domestica* L.

(A) Pests feeding on Leaves

(*a*) Biting:

1. Beetles, *Melolontha furcicauda*; *Lachnosterna longipennis*; *Microtricha cotesi*; *Adoretus* sp. and *Mimastra cyanea* (Coleoptera). Major pests. The adults feed on the foliage of peaches, plums, almonds, etc. in the Kangra Valley, and bring about complete defoliation. The grubs are underground. Active from May to July.

Control: Spray with lead arsenate 1 : 100 or DDT wettable 0.1% strength. Hoeing the tree basins or mixing BHC or soil fumigant in the soil proves effective.

(*b*) Sucking:

1. Peach curl aphis, *Brachycaudus pruni* Koch. (Aphididae; Homoptera). Infests peach, pear, almond trees in the hilly tracts of this State. The insect sucks sap from the leaves and, as a result of this, the leaves curl up and the attacked plants assume an unsightly appearance and do not bear any fruit. Active from March to May.

Control: Spray with nicotine sulphate 1 : 800, (ii) fish-oil soap 2.5% or (iii) BHC wettable 0.15%.

(B) **Borers**

1. Stem borer, *Sphenoptera* sp. (Buprestidae; Coleoptera). Fairly serious in Kangra Valley. The grubs bore into the bark and feed underneath it for some time and then bore into the trunk. Active during summer.
Control: Petrol or potassium cyanide fumigation.

2. Fruit fly, *Dacus zonatus* S. (Trypaneidae; Diptera). A major pest widely distributed. It attacks such fruits as peach, pear, mango, 'loquat', guava, and citrus. The maggots feed in the interior of the fruits which are often malformed, do not develop, and rot. Active from May to August.
Control: Poison bait spray or use of alures.

3. Wasp (unidentified) (Hymenoptera). At Palampur various wasps puncture the ripe fruit and feed inside. The attacked fruits rot and are rendered unfit for consumption. Active during May.
Control: Dust wasp nests with BHC.

(iv) WALNUT *Juglans regia* L.

(A) **Pests feeding on Leaves**

Leaf beetles. Minor pests. Some of the beetles which damage peach leaves also attack the leaves of this plant (*vide* Peach).

(B) **Borers**

1. Walnut weevil. *Alcides porrectirostris* Mashl. (Curculionidae; Coleoptera). A serious pest of walnuts in the hills at 3,500 to 8,000 ft. altitude, most destructive particularly at 6,000 to 7,000 ft. height. The damage is done by the creamy white grubs which feed on the kernel of the fruit and reduce it to a useless blackish mass. The attacked fruits usually drop down. The adults which are dark brown with prominent snout feed on the green, soft part of twigs, petioles of leaves, and young fruits. Active during summer but the greatest damage is caused during May-August.
Control: Spray with DDT 0.2%.

2. Walnut tree borer, *Batocera horsfieldi*—(Cerambycidae; Coleoptera). A minor pest in Kulu Valley. The grubs bore into the trunk and make tunnels.
Control: Petrol or potassium cyanide fumigation.

(v) FIG *Ficus carica* Linn.

(A) **Borers**

1. Stem borer, *Batocera rufomaculata* D. (Cerambycidae; Coleoptera) (Fig. 30). A major pest in Hoshiarpur district and Kulu Valley. The grubs cause the damage by tunnelling directly into the bark and then making circuitous galleries on the inner side. When full grown, the grub bores into the heart of the wood making a curved tunnel. The presence of small heaps of frass on the ground or on the stem is the symptom of the attack. The adults feed on

bark, leaves, and occasionally on fruit. The larvae are active throughout the year. One generation may take more than 12 months.

Control: *vide* Walnut.

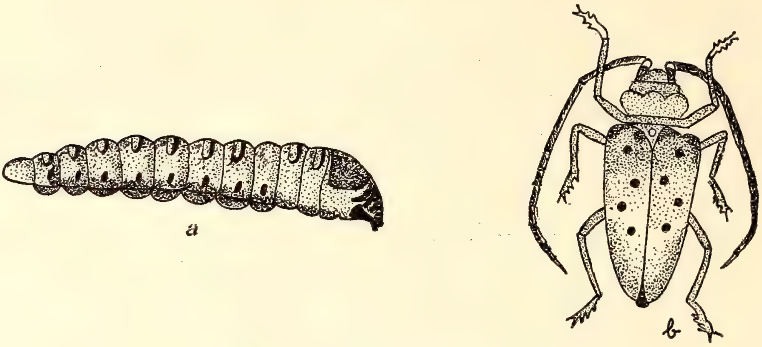


Fig. 30. Fig Borer, *Batocera rufomaculata* D. (*a*) grub × 2/3 (*b*) adult × 3/5.

(vi) MANGO *Mangifera indica* Linn.

(A) Pests feeding on Leaves

1. Mango hopper, *Idiocerus atkinsoni* Leth.; *Idiocerus clypealis* Leth. (Jassidae; Homoptera) (Fig. 31). Major pests, very destructive in Hoshiarpur, Gurdaspur, and Ambala districts. The nymphs which are pale yellow cause the greatest damage. The appearance of the mango inflorescence synchronizes with the first appearance of the nymphs which feed on the sap of the panicles during February-April. The attacked panicles wither and dry up and the flowers fall off prematurely without setting any fruit. 'Honey dew' secreted by the

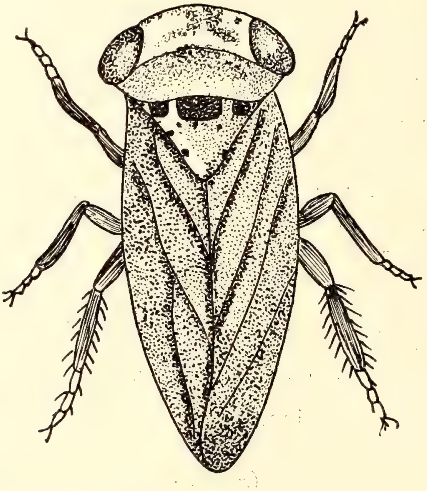


Fig. 31. Mango Hopper, *Idiocerus* sp.
(Adult × 12).

nymphs develops sooty mould and imparts blackish appearance to the plants. In case of severe infestation the entire crop may fail. Active from February to September, but does greatest damage during March and April. At Hoshiarpur it passes through two generations.

Control: Spray inflorescence with 0.15-0.2% DDT wettable.

2. Mango mealy bug, *Monophlebus stebbingi* Gr. (Coccidae; Homoptera) (Fig. 32). A major pest, particularly serious in Amritsar and Karnal districts. It has also been found damaging citrus, mulberry, plums, peaches, guavas, and figs. The females, which are wingless with flattened body covered with white mealy powder, descend to the ground in April-May and lay eggs in the soil around the base of the tree. The eggs hatch in January-February in the following year. The tiny nymphs crawl up their food plants and by the end of March all the females are fixed in thick clusters on the terminal tender shoots. The damage is done by the females by sucking plant sap. The attacked branches and shoots wither and the flowers do not set fruit at all. Only one generation in a year.

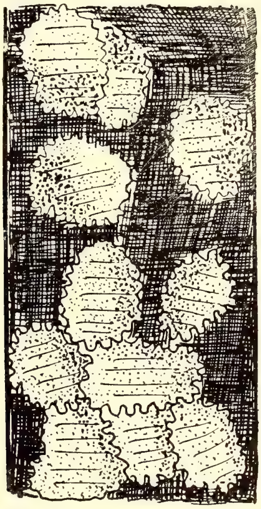


Fig. 32. Mango Mealy Bug, *Monophlebus stebbingi* Gr. × ½ to ⅔. Infested stem.

Control : (i) Banding the tree stems with Ostico or any sticky band and destroying all the nymphs collected below the band, (ii) spray with 0.2% BHC wettable when females cluster at the terminal shoots.

(B) **Borers**

1. Stem borer, *Batocera rufomaculata* D. A minor pest (*vide* Fig).

2. Fruit fly, *Dacus zonatus* S. and *Dacus ferrugineus* F. Minor pests. The maggots on hatching feed on the interior of the ripe fruits and render them unfit for consumption (*vide* Peaches and Plums).

(vii) GRAPE VINE *Vitis vinifera* Linn.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Hairy caterpillars, *Euprocitis lunata* Wlk. and *Euprocitis fraterna* M. (Lymantriidae; Lepidoptera). Minor pests. Also attack a number of other crops and fruit trees. The caterpillars feed on the leaves. The adults of *E. lunata* are pale, bright with a large black spot on each front wing. The adults of *E. fraterna* have bright orange front wings. Active during summer.

Control: Spray with 0.2% BHC wettable or dust with 5-7% BHC.

2. Til hawk-moth, *Heise convolvuli* L. (Sphingidae; Lepidoptera). A minor pest. Feeds on the leaves.

Control: Hand picking of caterpillars.

3. Death's Head moth, *Acherontia styx* W. (Sphingidae, Lepidoptera). A minor pest. The caterpillars feed on the leaves.

Control: Hand picking of caterpillars.

(*b*) Sucking:

1. Thrips, *Rhipiphoro-thrips cruentatus* Hood. (Thripidae; Thysanoptera). A minor pest. It also feeds on rose, terminalis, and 'jaman'. The reddish nymphs and black-brown adults feed on the underside of leaves by rasping the tissue and sucking the oozing sap. The attacked leaves turn pale, wither, curl up, and finally drop. The attacked plants yield less fruit and of inferior quality. Active from April to November (*vide* Onion).

2. Jassids (Jassidae; Homoptera). Some unidentified jassids also infest leaves of this plant and suck sap and finally bring about dropping of leaves (*vide* Cotton).

(viii) BER *Zizyphus jujuba* Lamk.

1. Ber beetle, *Adoretus pallens* B. (Rutelidae; Coleoptera). Widely distributed pest feeding on a number of plants and doing serious damage to 'ber'. The adults which are bright yellow in colour feed on the leaves at night and skeletonize them or bite holes in them. The insects are nocturnal in habit and are strongly attracted to artificial light. Active during summer causing serious damage during April-May. Only a single brood in a year.

Control: Spray with 0.15% DDT or lead arsenate 1 : 100.

(B) **Borers**

1. Fruit fly, *Carpomyia vesuviana* C. (Trypaneidae; Diptera). Serious pest in Hansi and Hosiarpur districts. The maggots feed inside the fruits which are rendered unfit for human consumption. Active from April to August.

Control: (i) Bait spray, (ii) soil fumigation or mixing BHC in the soil under the trees and (iii) deep hoeing to expose pupae to be destroyed by exposure or birds.

(ix) POMEGRANATE *Punica granatum* Linn.

1. 'Anar' caterpillar, *Virachola isocrates* Fab. (Lycaenidae; Lepidoptera) (Fig. 33). A major pest of 'anar' fruits in the lower

hills of the State. The caterpilllars bore into the fruits and feed inside. The attacked fruits are rendered unfit for human consumption. Active during summer.

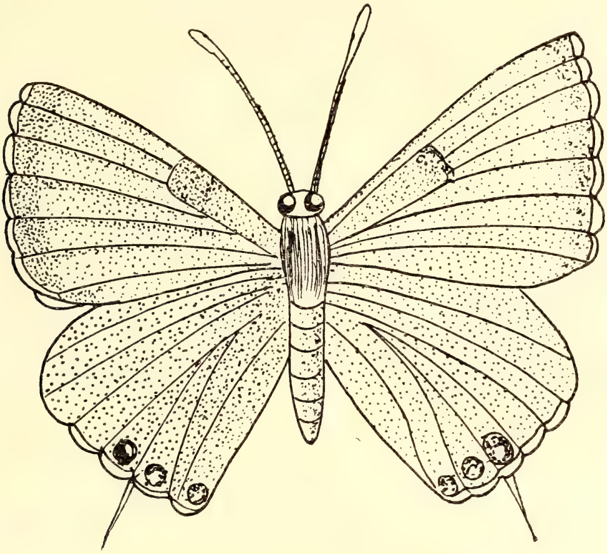


Fig. 33. Anar Butterfly, *Virachola isocrates* Fab. (Adult ×1½)

Control: Two or three sprays with 0.1% DDT wettable.

2. Blister beetle, *Mylabris macilenia* M. (Meloidae; Coleoptera) A minor pest. Adults feed on flowers (*vide* Jowar).

(x) CITRUS *Citrus* spp.

(A) **Pests feeding on Leaves**

(*a*) Biting:

1. Lemon butterfly, *Papilio demoleus* L. (Papilionidae; Lepidoptera). A serious pest of citrus nursery. The caterpillars alone are destructive. The greenish larvae feed on tender leaves eating them from the edges right up to the mid-rib. In severe cases of infestation the nursery plants are completely defoliated. Adults are bluish, having black front wings which are ornamented with yellow spots. Hind wings in addition have each a brick red oval spot. Active in summer and autumn months.

Control: (i) Hand picking of caterpillars and pupae, (ii) spray with 0.15% DDT wettable.

2. Citrus leaf miner, *Phyllocnistis citerella* St. (Phyllocnistidae; Lepidoptera). A minor pest, widely distributed. The adults are small and silvery white, forewings fringed with hairs and with a black spot and brown stripes, hind wings narrow, fringed. The caterpillars which are pale yellow mine the leaves which get curled up

and finally wither. Nursery plants suffer the most. Active throughout the year excepting January-February, when its activity is greatly reduced.

Control: Spray with 0.1% BHC or DDT wettable and repeat the treatment 2 or 3 times at fortnightly intervals.

(*b*) Sucking:

1. *Diaphorina citri* Kuw. (Psyllidae; Homoptera) (Fig. 34). A major pest of all cultivated varieties of citrus in Pathankot, Amritsar, and Sirsa. The brown adults and light yellow nymphs are both destructive. They suck the sap from the tender growing shoots and leaves and produce 'honey dew' on which black fungus develops. In severe infestation the plants produce little or no fruit. Active throughout the year, but does maximum damage during March-April, when the floral shoots wither. The insect passes through about nine generations in a year.

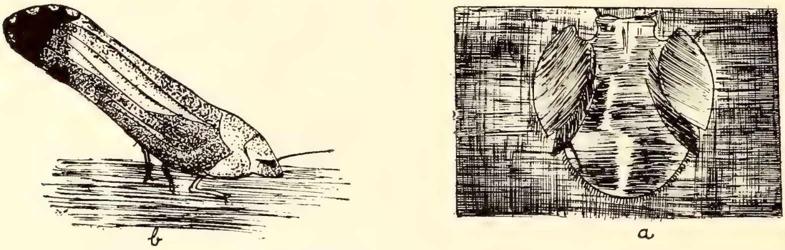


Fig. 34. *Diaphorina citri* Kuw., (*a*) nymph ×12, (*b*) adult ×12.

Control: Spray with (i) rosin compound 1 : 5, (ii) nicotine sulphate 1 : 800 or (iii) BHC wettable 0.15%.

2. White flies, *Dialeurodes citri* Ashmd. and *Aleurocanthus husani* Corbit (Aleurodidae; Homoptera). Major pests. There are many species but only two are of importance. *Dialeurodes citri* is present in all the citrus orchards in the Panjab whereas *Aleurocanthus husani* is met with in the south-eastern districts only. They infest orange, 'malta', lemon, and 'galgal'. Both the adults and nymphs suck the sap from the leaves and devitalise the plants. They also produce 'honey dew' on which black fungus develops and this interferes with photosynthesis. The attacked plants produce less fruit and of small size and poor quality.

Control: Spray with (i) rosin or fish-oil soap 2.5% or (ii) DDT 0.05% 2-3 times.

3. Scale insect, *Aspidiotus auranti* M. (Coccidae, Homoptera). A minor pest which sucks sap from the leaves.

(xi) GUAVA *Psidium guava* Linn.

1. Fruit flies, *Dacus zonatus* S. A major pest in Hoshiarpur district (*vide* Peaches).

10. PEST CONTROL

Due to the advance in the biological sciences entomological problems have also increased considerably. Previously, only the indigenous insect pests of a particular place caused damage to crops, forest trees, fruit plants, household material, stored grain, and other products. By the introduction of new improved varieties and quick measures of transportation, numerous pests get introduced from different States and foreign countries and even natural barriers do not restrict their spreading. To start with only a few of the introduced pests get established, but their adaptation and undisturbed multiplication in the new environments results in their assuming the pest status very soon. At the same time, by reducing the forest areas for habitation their natural enemies, like parasites or predaceous insects, birds and other animals, are destroyed or scared away. Accordingly, with the decrease in the number of enemies the pest population increases and with that their control becomes an acute problem.

Therefore, artificial control has to be adopted to keep the pests under check. Various methods are developed for this purpose and these are classified under (i) Preventive and (ii) Curative. The preventive measures include field sanitation through (1) eradication of weeds, (2) removal of plant remains, (3) opening of *bunds* and (4) flooding the fields; at the same time treating the seed or setts with some insecticides. Of the curative measures, such as (1) mechanical, (2) cultural, (3) insecticidal, (4) biological, and (5) legislative, all have relative efficacy under different conditions and are adopted according to the circumstances.

However, the insecticidal method has direct effect and, if it proves successful, it convinces the people of its efficacy and thus gives the desired encouragement. Various insecticides work differently in killing the pest. These are applied as stomach or contact poisons, and the latter may be of the nature of resulting in quick knock down or with residual effect keeping the toxicity for periods of varied lengths. The fumigants produce lethal concentration of specific gases which results in the mortality of insects exposed to it.

NOTE:

In this note, it is not considered necessary to discuss the various methods of control at length. Only the insecticides, to which reference is made under the various crop pests, are mentioned in order to acquaint the public with the mode of their preparation and the formulæ to be adopted.

1. POISON BAIT.

Sodium fluosilicate	...	2 lb.
or		
Benzine Hexachloride 10%	...	1 lb.
Bran	...	40 lb.
Mollasses	...	1 lb.
Water		Enough to moisten the material for broadcasting.

The poison should be mixed last of all and stirred well. The mixture should be broadcast in the evening, the quantity per acre depending on the intensity of attack.

2. BHC AND DDT 5% OR 10% dusts. These are available in the market from various firms under different proprietary names, and in different strengths. For

furthur dilutions the higher strengths may be diluted proportionately with talc powder or cowdung ashes. Dusting is managed with different types of dusting machines as hand duster of the plunger type, rotary dusters, or power dusters. The type of dusting machine to be utilised depends on the area to be covered and the intensity of attack.

3. Pyrodust 4,000. Available from Bombay Chemicals, Bombay, in the required strengths. It is Pyrethrum production and, therefore, harmless for dusting the vegetable crops.

4. Sulphur dusting. Fine sulphur 200-300 mesh is available in the market. It may be dusted undiluted but the operator must use eye goggles.

5. Nicotine sulphate.

Nicotine sulphate 40%	1 oz.		
Water	5 gals	to make	1 : 800
	6.25 gals	,,	1 : 1000

Nicotine sulphate 40% is available in the market and it is simply to be diluted with water for spraying. If ordinary soap is added as spreader at the rate of 12 oz. to the above mixture it will increase the efficacy and the quantity of water may also be increased a little.

6. Rosin compound.

Crude rosin	12 lb.
Washing soda	2 lb.
Water	10 gals.

Boil rosin and washing soda in a little water and continue adding little warm water to the mixture till the entire quantity of water is consumed and the mixture assumes coffee colour. Keep the mixture testing at intervals by adding a few drops of it in a cup of cold water. When the insecticide is fully cooked it will mix with the water without producing milkiness at which stage the material should be strained through muslin cloth and the required dilution made for application.

7. Fish-oil rosin soap. This is available ready made from various firms as the Karela Soap Institute, Calcutta. Slice the soap in a little hot water and dissolve it by stirring. Add the remaining water gradually. The insecticide is very effective against sucking insects and the usual dose is 1 lb. in 4 gallons of water.

8. Lead arsenate.

Lead arsenate powder	2 lb.
Water	80 gals. (60 gallons for beetles).

Mix the powder in a little water with a stick and then add slowly the remaining water. The mixture should be stirred vigorously during the process of spraying.

Since lead arsenate is a deadly poison all care should be taken to safeguard human beings and the cattle. The operator should take all preventive measures, avoid inhaling, and should also use goggles.

9. Spraying with DDT or BHC.

For this purpose 50% wettable (water dispersible) powder is used, and for making the required dilutions the quantities given below should be utilised.—

(i) 0·025%	2 oz.	of powder in	24	gallons of water.
(ii) 0·05%	2 oz.	,,	12	,,
(iii) 0·1%	2 oz.	,,	6	,,
(iv) 0·15%	3 oz.	,,	6	,,
(v) 0·2%	4 oz.	,,	6	,,

10. Tobacco decoction.

Tobacco refuse	1 lb.
Ordinary washing soap	4 oz.
Water	1 gal.

Soak the waste tobacco overnight in the entire quantity of water. Then boil the mixture for a few hours, allow it to cool, and then strain it through a muslin cloth. This will separate a coffee coloured liquid. Add to this extract thin pieces of soap and stir vigorously to dissolve it. Dilute the final mixture 5 times with water before use.

11. Pyrocolloid. It is available from Bombay Chemicals, Bombay, in emulsion form. For application it should be diluted in the ratio of 1 : 800 or 1 : 1000.

12. Diesel-oil emulsion.

Diesel-oil	...	5 lb.
Potash vegetable or fish-oil soap	...	2 lb.
Water	...	1½ gals.

Boil the mixture in an empty kerosine-oil tin. Remove it from the fire and pump the mixture vigorously with great pressure into another tin. Repeat the process several times until free oil is not visible on the surface of the emulsion. The matured insecticide should be diluted with water in the ratio of 1 : 33 before spraying.

13. BHC or DDT emulsion. Available ready made in the market from high class firms dealing with these products. The material is further diluted 1 : 500.

14. Lime sulphur wash.

Flower of sulphur (200–300 mesh)	...	5 lb.
Unslaked lime	...	2½ lb.
Water	...	4 gals.

Slake lime in about one gallon of water in an earthen vessel or empty crude oil barrel (in no case in a copper vessel) and mix sulphur to get a uniform paste. Then add the remaining water with some force. Mark the depth of the mixture on a piece of wood and boil the mixture till it assumes dark, reddish brown colour, and should not be allowed to change to greenish. The mixture should be thoroughly stirred during this process and the original level maintained by adding more water gradually. Strain the mixture and dilute the stock solution 6–10 times before use.

15. Poison bait spray.

Lead arsenate	...	2 oz.
Molasses	...	4 oz.
Water	..	8 oz.

Mix the ingredients to prepare a syrup. Only a portion of the foliage on a tree should be sprayed with it.

16. Sanitary fluid. It is available ready made in the market. About 4% solution is enough to use before planting the sugarcane setts or mixing in the soil.

17. Methyl Bromide fumigation.

This fumigant is available in steel cylinders of 30 lb. and 180 lb. capacity. The fumigant must be used in airtight godowns or under waxy tarpaulins.

The gas cylinder is placed over a weighing scale in the open. The required quantity of gas is introduced into the godown or inside the tarpaulin covering the bags, through a rubber hose. One end of the hose is connected to the release valve of the gas cylinder placed over the weighing scale and the other end introduced into the room or the tarpaulin covering through a hole made in the wall or the soil. The free ends of the tarpaulin should be well buried in a small trench and nicely covered over with soil to avoid leakage. The end introduced in the chamber should be made perfectly airtight.

A dose of 1 lb. per 1000 cu.ft. of space with an exposure of 12 hours only yields cent per cent mortality without affecting adversely the germination of seed. However, for the fumigation of cotton seed in bags under tarpaulin, exposure of 19–20 hours is effective in killing 90–95% larvae of Pink Bollworm.

18. Potassium cyanide fumigation. It is very effective in killing the stem borers of fruit trees. The holes caused by the borers should be cleaned and all frass removed. One small crystal of pot. cyanide be introduced within the hole with the help of a forceps and the hole plugged well and plastered with mud from outside. The cyanide fumes penetrate into the tunnel and kill the insect inside.

19. Paradichlorbenzine. This is used as soil fumigant to destroy insects which pass a part of their life-cycle in the soil below the infested trees. The fumigant is introduced into the soil, mixed with it and covered well.

20. Allures. Clensel 'A' (available in the market) diluted in the ratio of 1 : 30 should be put in wide mouth bottles (about half filled) which are hung on the trees. Fruit flies are attracted to it and are killed.

21. Banding. Ostico band is available in the market. This should be tied round the stem of the trees at a height of about 2 ft. from the ground level. Preferably two bandings should be used one at 2 ft. and the other at 3 ft. height above the ground level. This will increase the efficacy because the insects which may escape the first band will be checked by the second one.

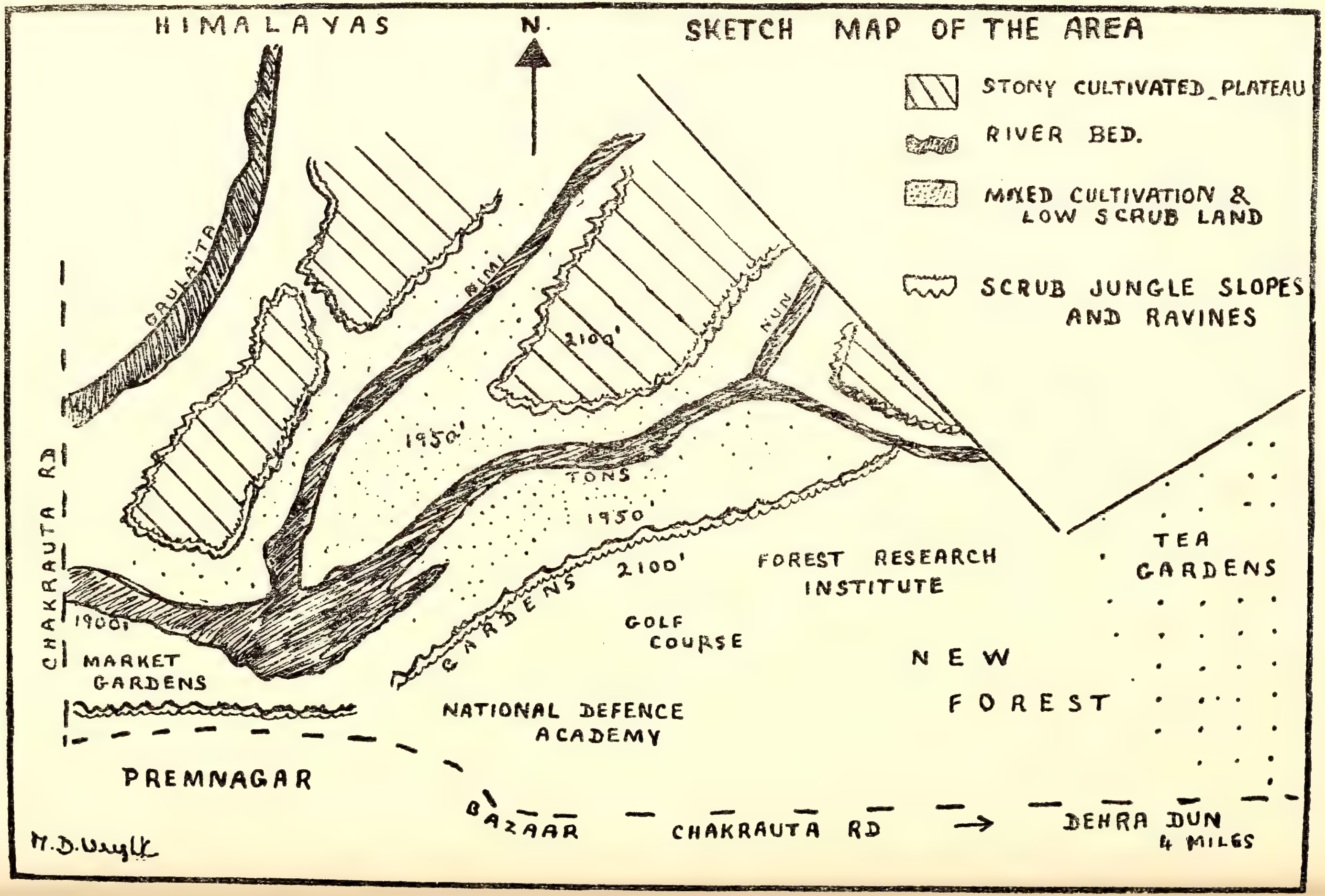
If Ostico is not available a thick syrup-like mixture be prepared with rosin mollasses and glycerine and cotton soaked in this be tied in the form of a band.

The crawling insects which get stuck to the band or are clustered at its border should be brushed daily in kerosinized water and destroyed.

The bands should be replaced by new ones after 10–15 days if their efficacy appears to be declining.

List of Vernacular and Scientific names of Plants Mentioned in the text

Anar, *Punica granatum* Linn.
Bajra, *Pennisetum typhoides* Stapf et Hubbard
Baru, *Sorghum helepense* Pers.
Bhindi, *Hibiscus esculentus* Linn.
Ber, *Zizyphus jujuba* Lamk.
Cucumber, *Cucumis sativus* L.
Dhaincha, *Sesbania aegyptiaca* Pers.
Galgal (proper), *Citrus medica* var. *galgala*
Ghia tori, *Luffa aegyptiaca* Mill.
Guara, *Cyamopsis psoralioides* DC.
Gulkhera, *Althea rosea* Linn.
Japan Sarson, *Brassica napus* L.
Jaman, *Eugenia jambolana* Lamk.
Jowar, or Chari *Sorghum vulgare* Pers.
Kadu, *Lagenaria vulgaris* Ser.
Karela, *Momordica charantia* L.
Kangibooti, *Abutilon indicum* G. Don
Kuchri, *Malvastrum tricuspidatum* A. Gray
Loquat, *Eriobotrya japonica* Lindl.
Lucerne, *Medicago sativa* Linn.
Maina, *Medicago denticulata* Willd.
Malta, *Citrus sinensis* Osbeck.
Mash *Phaseolus mungo* forma *roxburghii* Prain.
Methi, *Trigonella foenum-graecum* Linn.
Moong, *Phaseolus mungo* Linn. var. *radiatus*
Pālak, *Spinacia oleracea* L.
Rāya, *Brassica rapa* L.
Singhara, *Trapa bispinosa* Roxb.
Sann hemp, *Crotalaria juncea* Linn.
Sankukra, *Hibiscus cannabinus* Linn.
Sarkanda, *Saccharum spontaneum* Linn.
Sarson, *Brassica campestris* Linn. var. *sarson* Prain.
Senji, *Melilotus alba* Lamk.
Saunchal, *Malva parviflora* Linn.
Sem, *Dolichos lablab* Linn.
Swank *Skimmia laureola* Hk. f.
Tinda *Citrulus fistulosus* Stocks
Toria, *Brassica juncea* Coss.
Water melon, *Citrullus vulgaris* Schrad.


SKETCH MAP OF THE AREA
HIMALAYAS
N.
STONY CULTIVATED PLATEAU
RIVER BED.
MIXED CULTIVATION & LOW SCRUB LAND
SCRUB JUNGLE SLOPES AND RAVINES
GAULAITA
BIMI
NUN
TONS
2100'
1950'
1950
1900'
2100'
CHAKRAUTA RD
MARKET GARDENS
GARDENS
GOLF COURSE
FOREST RESEARCH INSTITUTE
TEA GARDENS
NEW FOREST
NATIONAL DEFENCE ACADEMY
PREMNAGAR
BAZAAR
CHAKRAUTA RD
DEHRA DUN 4 MILES

NOTES ON THE BIRDS OF A SELECTED AREA OF DEHRA DUN—JUNE 1946 TO JULY 1951

BY

MRS. M. D. WRIGHT (Deceased)

(With a sketch map)

Five years in a beautiful part of Dehra Dun, below the toothills in the Dun Valley that lies between the Siwalik Range and the outer western Himalayas, provided an opportunity of keeping a watch on the general bird life of my immediate vicinity.

The avifauna was of special interest, being an intermingling of hills and plains species. Besides the normal autumn and spring migrations, it was possible to gain some idea of the extent of local seasonal movements between the hills and the Dun, and the plains and the Dun.

As a supplement to the June 1935 number of the Indian Military Academy's *I.M.A. Journal*, Mr. B. B. Osmaston published the 'Birds of Dehra Dun and Adjacent Hills[1]'. I have aimed at enlarging on the status of only those species which came within the limits of my small study area.

THE AREA

At an average altitude of 2,000 ft. above sea level, roughly four miles long by two and a half miles wide, it comprised the adjoining grounds of the National Defence Academy and the Forest Research Institute, and the valley of the Tons River lying along their northern boundaries.

Climatic conditions varied from a fairly cold winter (minimum 38°F.), a summer of first dry then damp heat (maximum 108°F.), and a mean annual rainfall of about 50 inches, chiefly in the SW. Monsoon—July to September. In early spring, the coldest period, bad weather and snow on the hills meant the arrival of more hills species as spring visitors, and the reduction of many plains species.

Types of country were:

Wooded Parts: 1. The grounds of the Institutions, including their gardens and the golf course between them, planted with flowering and fruit trees and shrubs.

2. The planted experimental forests of the 'New Forest'.

3. The tea gardens, sheltered by tall shade trees, mostly Toon (*Cedrela toona*).

4. The scrub jungle-covered slopes and ravines rising up from the valley, and bordering on the gardens. Sal (*Shorea robusta*) was the main tree here.

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[1] *i.e.* the hills in the immediate neighbourhood of Mussoorie as well as those of Jaunsar-Bawar up to the limit of snow. EDS.

Open country of the Valley:

1. The river beds of the Tons, Nun, Nimi, and Gaulaita, the last always dry. Typical boulder-strewn mountain waterways or *rao*'s usually dry between February and July.
2. Waste lands between and along the river beds, covered with Ber (*Zizyphus*) and bans (*Adhatoda vasica*) scrub.
3. Cultivation. Main crops of rice and wheat.
4. Dry stony cultivation on relict plateaux standing between the river beds.
5. The sewage-irrigated area of the market gardens. As there was no permanent water within the area, the water loving species were very limited.

The Notes

Throughout the period notes were taken on walks arranged to cover most parts of the area at least twice a month.

All identifications were visual or aural and as correct as they could be, based on descriptions in Whistler's POPULAR HANDBOOK OF INDIAN BIRDS, Sálim Ali's INDIAN HILL BIRDS, B. B. Osmaston's BIRDS OF DEHRA DUN AND THE ADJACENT HILLS, and Stuart Baker's FAUNA OF BRITISH INDIA (BIRDS).

Only the status of a bird within the limits of the area was noted, regardless of what it might have been elsewhere in the Dun.

Earliest seen: The earliest date recorded for any season, in any year.

Latest seen: The latest date a bird was seen or heard in any year. A check list was kept towards the end of winter and summer for this purpose.

Breeding: Evidence of breeding from behaviour or presence of a species during the nesting season was noted rather than close observation of nidification.

An average minimum bird count was kept for the period of one full year in the market garden area to help form a more accurate estimation of status. (See *JBNHS* 48 (3), August 1949.)

Species Observed

Corvus macrorhynchos. Jungle Crow.

Resident. The common crow of the area in all types of country.

Breeding: February to end of July. Favouring Shisham and Sal trees. Though in pairs, small groups collected socially before roosting.

Flocks: September. Feeding grounds in the valley about irrigated fields and sewage. Large roosting flights formed by parties collecting at certain meeting points. Communal roosts on trees of golf course and New Forest.

Corvus splendens. Common House Crow.

Resident. Comparatively few. Mainly about the bazaar area.

Breeding: April to July.

Flocks: September. In small parties, often with Jungle Crows, in the valley. In December, large flocks about wheat irrigation, digging their bills into the wet earth.

Urocissa melanocephala. Redbilled Blue Magpie.

Probably resident. Not common. Except for once in New Forest area, always seen about the same stretch of scrub jungle slopes.

Breeding: Pairs seen in February, April, and July.

Parties: December 14th, a small party.

Dendrocitta vagabunda. Indian Tree-Pie.

Resident. Common in most types of country. Their calls not as musical as they often are in the plains.

Breeding: Courtship: From February. The action of parent feeding young as part of display noted.

Nesting: April to June. Sites high up on trees in thickly wooded parts. Very secretive behaviour.

Young: Family parties in July and August. The young with short tails shepherded noisily about by parents.

Dendrocitta formosae. Himalayan Tree-Pie.

Winter. Not common. A few small parties regular visitors to the Gaulaita, Nimi, and Nun valleys. From headquarters on scrub jungle slopes, destructive raids on ripe rice crops in open cultivation were carried out.

Earliest seen: September 17th.

Latest seen: May 10th.

Parus major caschmeriensis. Indian Grey Tit.

Resident. Common in all wooded parts and trees in cultivation.

Breeding: Courtship: March and April. A double note call monotonously repeated.

Nesting: May and June. Holes in trees of tea gardens and scrub jungle particularly.

Young: Out of nest in July.

Parties: From October, parties were part of every hunting association of small birds.

Parus monticola. Greenbacked Tit.

Winter. Not common. Occasional small parties with Grey Tits and others of the association in wooded parts.

Earliest seen: November 22nd.

Latest seen: March 13th.

Lophophanes melanolophus. Crested Black Tit.

Winter. Not common. On February 24th, two were working high up on trees of the tea gardens with an association of other small birds.

Garrulax leucolophus. Whitecrested Laughing Thrush.

Resident. Common in parties that moved about under thick cover of scrub jungle ravines. Their outbursts of ringing calls might be described as 'part singing' with a chorus *quick woooork! quick woooork! quick woooork!*

Breeding: Comparatively quiet during summer and rains.

Sitta castanea. Cinnamonbellied Nuthatch.

Probably resident. Not common. Two were seen working together on trees in tea gardens in January and February.

Turdoides somervillei. Jungle Babbler.

Resident. Common in gardens and wooded parts. In parties of up to 20 members. Smaller parties in summer and rains.

Breeding: March to August.

Young: April 16th, earliest seen out with adults.

Argya caudata. Common Babbler.

Resident. Common in bushy open country.

Breeding: Paired off in March.

Nesting: April to June. The nests placed in hedges and thickets.

Young: From June, out with parents.

Parties: October, large parties formed.

Pomatorhinus erythrogenys. Rustycheeked Scimitar Babbler.

Resident. Common in scrub jungle. Usually in pairs, often appearing in full view at edges of gardens. Characteristic *qui-puoip!* calls early mornings and evenings.

Breeding: Courtship. A call *shwago!* frequently heard in April and May.

Nesting: April to August.

Young: Out of nest in June.

Pomatorhinus schisticeps. Slatyheaded Scimitar Babbler.

Resident. Fairly common in pairs and small parties in thick scrub jungle. Often feeding on ground with Rustycheeked Scimitar Babblers. The party call note *chirrrrr, chirrrr.*

Breeding: Courtship: March and April. The mating call a loud single note rapidly repeated.

Chrysomma sinensis. Yelloweyed Babbler.

Resident. Common in parties about cultivation. A trilling party call note.

Breeding: Courtship: End of February, solitary song from an exposed perch. Pairs in March.

Nesting: April to August, among bushes in cultivation.

Young: From June, seen out with parents.

Parties: October, increased in size by January, coming up ravines into garden hedges, often in company with Franklin's Wren-Warblers.

Pellorneum ruficeps. Spotted Babbler.

Resident. Common in small parties under thick cover of scrub jungle slopes. Skulking habits. A long melodious call *chi-che-chi, chaw che, che chi chaw* heard all the year round.

Breeding: Courtship: End of February, another call *wheech-cheer* monotonously repeated, became louder and more insistent as breeding season progressed. Seldom heard after September.

Young: From May. Family parties of tailless young progressed along the thick carpet of leaves with a peculiar flopping motion, like large rats.

Parties: September.

Stachyridopsis pyrrhops. Redbilled Babbler.

Resident. Common in parties under cover of scrub jungle and bushes of tea gardens. Skulking habits. The party call a weak plaintive *tee-weer.*

Breeding: Courtship: A mating call in March, a resonant whistle of a single note quickly repeated.

Nesting: April to end of rains. Neat cup-shaped nests placed fairly low in thick shrubbery.

Young: From May, in family parties.

Parties: October. Large parties join the winter hunting associations in among the tea bushes.

Aegithina tiphia. Common Iora.

Resident. Fairly common about gardens and wooded parts.

Breeding: Courtship. Mating calls from February are varied, but *weeeeee-tiu !* the most heard.

Sometimes in small parties in winter with hunting associations.

Chloropsis aurifrons. Goldfronted Chloropsis.

Not common. On March 31st a solitary bird on a Sal tree was calling beautifully.

Microscelis psaroides. Himalayan Black Bulbul.

Spring. Travelling flocks regularly appeared in gardens and wooded parts, sometimes remaining in the same small locality for two or three days. Flowering trees of Sal, Bokain, Simul, and Eucalyptus attracted them. Calls usually high pitched and squeaky, sometimes a lazy *cheng-chaung.*

Earliest seen: January 15th. Largest numbers: mid-March. Latest: March 25th.

Molpastes cafer. Redvented Bulbul.

Resident. Common, particularly in open cultivation.

Breeding: Courtship: April, pairs broke away from parties.

Nesting: May to August, one nest in the garden placed about 20 ft. high on a Shisham tree.

Young: June, the earliest out with parents.

Parties: From September. Large and lively parties attracted by ripe *Zizyphus* fruit in the valley and joined forces with Whitecheeked Bulbuls to wreak havoc on pea plants in gardens.

Molpastes leucogenys. Whitecheeked Bulbul.

Resident. Common, particularly about gardens and scrub jungle. *M. l. leucotis* with the short crest common in Delhi was never seen here.

Breeding: Courtship: April, pairs broke away from parties.

Nesting: May to August in thick scrub jungle. Inconspicuous and quiet in behaviour, but many nests came to grief in very exposed positions.

Parties: From September. Increased in size in November when attracted by garden plants.

Otocompsa flaviventris. Blackcrested Yellow Bulbul.

Winter. Fairly common in wooded parts and gardens. Always seen in pairs. A pair would visit the same locality punctually every day for a time. The extra musical bulbul call usually attracted attention first.

Earliest seen: November 4th, usually mid-November. Latest: January.

Never seen in summer.

Certhia himalayana. Himalayan Tree-Creeper.

Winter. Fairly common. Two or three usually working up trees with travelling hunting associations in wooded parts.

Earliest seen: October 14th—increased by December. Latest: March 20th.

Tichodroma muraria. Wall-Creeper.

Winter. Fairly common. A few solitary birds took up territories along the river banks and could usually be seen there, working up the perpendicular faces, or squatting on the boulders of the bed.

Earliest seen: November 12th. Latest: March 16th.

Saxicola caprata. Pied Bush-chat.

Mainly summer. Common everywhere except forest in summer.

Breeding: Courtship: March, a large increase in numbers, particularly females. Male song and display of flight and fluffing out the white wing feather one of the main features of open country.

Nesting: April to August. Nests very cleverly concealed.

Young: From May, family parties hunting, young in female plumage.

Decrease: September. From October males solitary within territories, females very scarce.

Saxicola torquata. Collared Bushchat.

Winter. Fairly common in open country holding solitary territories. Females in the minority.

Earliest seen: September 3rd. Latest: End of April.

Largest numbers: End of February. Many more females arrived.

Rhodophila ferrea [ferrea]. Dark-grey Bushchat.

Winter. Common, in all types of country except forest. Mostly males holding solitary territories. A male took up the same territory in a garden three years running.

Earliest seen: October 5th. Early arrivals mostly in female plumage. About a week after the earliest they were common in pairs and small parties for a few days before decreasing and spreading out. Latest seen: End of March.

Cercomela fusca. Brown Rock Chat.

Resident. Not common. A few pairs always about the main F.R.I. building; not noted elsewhere.

Oenanthe picata. Pied Wheatear.

Winter. Not common. Seen solitary frisking about the boulders of the dry river bed, and on a disused stone hut in the valley. A continuous bobbing movement when perched, then a low direct flight to the next perch.

Earliest seen : December 17th. Latest : February 12th.

Phoenicurus ochrurus. Black Redstart.

Winter. Fairly common about hedges and ravines in dry bushy parts, holding solitary territories. Very much paler than the eastern race. In winter 1950 females were in the majority.

Earliest seen: September 26th. On arrival in 1950, 3 or 4 females were together. Latest : Mid-May.

Chaimarrhornis leucocephalus. Whitecapped Redstart.

Winter. Fairly common. Holding territories, solitary or in pairs, along stretches of river banks and canals where they seemed to prefer those parts frequented by men and animals. One made its headquarters in the vicinity of the Academy buildings some distance from water for two years running. Another spent much time flying in and out of the horses' stables.

Earliest seen : October 17th. Latest : March 4th.

As the river dried up, their numbers along the canals increased.

Rhyacornis fuliginosus. Plumbeous Redstart.

Winter. Fairly common on rivers and canals. Sometimes in pairs. The female often in company with a Whitecapped Redstart seemed to work much harder than the male.

Earliest seen : October 21st. Latest : February 27th.

Cyanosylvia svecica. Bluethroat.

Winter. Fairly common. Usually solitary in vegetation round damp localities and in standing crops.

Earliest seen : September 3rd. Latest : May 4th.

Largest numbers : April, often in pairs and small parties. Males perched on exposed positions singing a full vigorous song.

Calliope pectoralis. Himalayan Rubythroat.

Winter. Seldom seen. Usually solitary, hunting quietly on the ground at the base of hedges and shrubbery in cultivation and wooded parts. When alarmed, the action of 'freezing' with neck stretched upwards to reveal the scarlet throat patch like a danger signal, was noted. Much darker than the Common Rubythroat.

Earliest seen : October 19th. Latest : January 17th.

Adelura caeruleocephala. Blueheaded Robin.

Spring. More common some years than others, but regular visitors to parts where woods border on open country. Males always more numerous and conspicuous than females, the sexes never seen together. Habits a mixture between those of a Flycatcher and a Redstart. A sharp *trrr* the only call note heard. Their appearance usually coincided with the coldest spell of weather over the hills.

Earliest seen : January 6th. Males usually became common at once Latest : March 3rd.

Saxicoloides fulicata. Brownbacked Indian Robin.

Resident. Common particularly about bushy parts of waste lands and broken stony ground, where pairs held territories.

Breeding: Courtship: From end of February, song and display by males.

Nesting: March to August.

Copsychus saularis. Magpie Robin.

Mainly resident. Common about gardens and round villages in cultivation. Females scarce out of breeding season.

Breeding: Courtship: End of March 'sotto voce' song from male from inconspicuous perch.

First week of April, an increase of females greeted by beginning of loud full song from high conspicuous perches, aggression, and display by males. A repetition of this behaviour in October for a short while.

Nesting: May to August. Dry leaves collected and filled into natural holes or nesting boxes, mostly by females.

Young: June 6th, the earliest young being fed at nest. One parent always on guard while other foraged. The *karrr* warning note used frequently.

Decrease: October, majority of females departed. Males then hunted solitary within territories very quietly.

Turdus atrogularis. Blackthroated Thrush.

Mainly spring. Fairly common in nearly all types of country in mixed parties, often feeding on the ground. The distinctive call note usually heard first from high up on a tree-top.

Earliest seen: December 6th. Largest numbers: February. Latest: end of March.

Several other thrushes appeared as winter visitors. Tickell's Thrush almost certainly arrived about January and fed solitary and very quietly on lawns, stopping every few moments to take a wary look round.

Monticola cinchlorhyncha. Blueheaded Rock Thrush.

Spring and autumn passage. Not common. A few brief appearances in scrub jungle and gardens, probably on passage.

Earliest seen: September 26th, a solitary female hunting confidently about the garden. Latest: April 13th, two or three males chased each other across a scrub jungle path, at least one female also present.

Monticola solitaria. Blue Rock Thrush.

Not common. On May 1st 1950 one appeared sharply bowing on a garden path and high ledges of the roof.

Geokichla citrina. Orangeheaded Ground Thrush.

Summer. Commonly heard and often seen in wooded parts feeding quietly on the ground. Shy of observation. No signs of them in winter.

Earliest song heard: April 13th. Latest: Mid-September.

Breeding: Courtship: Mid-April to September. Male song uttered at dawn and sunset from a high perch on a horizontal branch of a tall tree. While thus engaged, no objection to observation. The beautiful mellow song crowded with many imitations of other birds.

A renewed outburst of song in July.

Myophoneus caeruleus. Himalayan Whistling Thrush.

Winter. Fairly common in wooded parts. Usually solitary holding territories, but on arrival and before departure often in pairs. In winter it starts the dawn chorus of song, with two or three shrill whistles, followed by a short version of the lovely song; this was repeated in the late evening.

Earliest seen: October 6th. The first song usually heard about four days after. Latest: end March.

Prunella atrigularis. Blackthroated Accentor.

Winter. Not common. In January 1949 a few were scattered about *Zizyphus* and other low scrub in the Gaulaita valley. They worked their way quietly in and out of the bushes.

Muscicapa strophiata. Orangegorgetted Flycatcher.

Winter. Fairly common in thickly wooded parts where the lower branches of large trees were favourite perches to hunt from. The call note, a deep throaty *tchak!* attracted attention. Another call, a very high pitched monotonous *peep*, *peep*, *peep* continuously repeated seemed to be usually made by the female, though the male also intersperses them with the first call. Headquarters were established, sometimes in the same spot every year.

Earliest seen: end of October. Latest: end of March.

Muscicapa parva. Redbreasted Flycatcher.

Winter. Fairly common. Conspicuous in call and action about gardens and edges of wooded parts, groves, and in open country. Usually solitary. No vestige of red seen on any of their breasts.

Earliest seen: October 8th. Latest: April 13th.

Largest numbers: April, becoming suddenly much more common and often in pairs.

Alseonax latirostris. Brown Flycatcher.

Winter. Not common. Occasionally seen solitary in gardens and wooded parts, hunting from high perches usually with an association of small birds.

Earliest seen: October 8th. Latest: February.

Muscicapula tricolor. Slaty Blue Flycatcher.

Winter. Common in gardens and the undergrowth of wooded parts, low scrub in the valley. On arrival each appeared to take up a territory using the lower branches for observation perches, but too active to perch for long. Usual call a rapid *tick! tick! tick!* sometimes *peep-peep-kit!* In 1950 the majority seen were in female plumage; other years about equal.

Earliest seen: October 16th. Latest: end of March.

Muscicapula rubeculoides. Bluethroated Flycatcher.

Summer. Common in scrub jungle ravines and other thickly wooded parts. Partial to the branches of banyan and peepul trees. Inquisitive rather than shy. Their song a feature of their habitat.

Earliest heard: April 10th. Latest: October 3rd.

Breeding: Courtship: Mid-April, in pairs. Loud and very lively song from the male and aggressive chases. Territories established especially in ravines where several pairs held closely adjacent ones.

Nesting: May–September.

Neither Tickell's nor the Blacknaped Flycatchers were seen in the study area.

Muscicapula superciliaris. Whitebrowed Blue Flycatcher.

Winter. Not common. A solitary bird was in the garden, hunting from perches on trees and shrubs from March 14th to 18th, 1950.

Niltava sp. ? Niltava.

Winter. Not common. Seen in January two years running in the same small plantation of Teak in New Forest area, hunting among the undergrowth. The male had bright rufous flanks but there was no good view of chin and breast. One in female plumage had a conspicuous crescentic patch white on the brown breast.

This was probably the Small Niltava (*N. macgrigoriae*) being too small for the Rufousbellied Niltava (*N. sundara*).[1]

Eumyias thalassina. Verditer Flycatcher.

Autumn and spring. Not very common. Usually solitary, hunting quietly from trees in wooded parts and cultivation. Very seldom noted between spring and autumn passages.

Earliest seen: August 13th. Latest: March 20th.

Largest numbers: March, sometimes small scattered parties.

Culicicapa ceylonensis. Greyheaded Flycatcher.

Mainly autumn and spring. Common, in wooded parts. Usually with hunting associations, where the lively behaviour and distinctive call attracted attention. Comparatively few seen between autumn and spring passages.

Earliest seen: October 9th. Latest: March 20th.

Largest numbers: Early March, in pairs and sometimes small parties.

Tchitrea paradisi. Paradise Flycatcher.

Summer. Remarkably common wherever there are trees. Monopolising attention by self-possessed behaviour, appearance, and calls. Often perched on wire surrounds of garden mali ponds and hawked insects off the surface of the water.

Breeding: Courtship: April, on arrival, males chased each other aggressively through the foliage with excited call.

Nesting: May to July. In decreased numbers. Quieter and more secretive behaviour. Pairs in definite territories. Most nests low down, but one high up on a garden Jacaranda. Incubation equally shared by the sexes.

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[1] The flanks of *N. macgrigoriae* are grey with no rufous on them. EDS.

Young: From July, in female plumage hawking confidently with parents.

Earliest seen: April 1st. Latest: October 20th. Majority by end of September.

Largest numbers: About 10 days after arrival.

Chelidorhynx hypoxanthum. Yellowbellied Fantail Flycatcher.

Winter. Fairly common. Usually solitary in lightly wooded parts, behaving in its charming manner on high perches on trees. Sometimes with an association of birds. The high *quit!* is a distinctive call note.

Earliest seen: November 28th. Increased by late December. Latest: February 27th.

Rhipidura aureola. Whitebrowed Fantail Flycatcher.

Resident. Fairly common. Usually in pairs about gardens, light forest, and groves of trees in open country.

Breeding: Hot weather and rains.

Young: In May.

Rhipidura albicollis. Whitethroated Fantail Flycatcher.

Resident. Common. In the greater cover of scrub jungle ravines, but coming freely into gardens. The call not so perfect as the White-browed Fantail Flycatcher's, and a harsh note most often used.

Breeding: May to August. One nest was ridiculously low down and conspicuous in a ravine, a parent danced madly on the bough while its eggs were being observed.

Lanius vittatus. Baybacked Shrike.

Mainly summer. Fairly common in summer. The few resident in territories in dry bushy parts of the valley. Usually in pairs.

Breeding: Courtship: End of April, noisy behaviour.

Lanius schach. Rufousbacked Shrike.

Resident. The common shrike of the area. Solitary in winter, holding territories in open country, especially cultivation.

Breeding: Courtship: End of January. Calling to each other and singing from perches.

April—Full challenging song, crowded with imitations.

Nesting: April to June. Well hidden in thick masses of foliage, often the end of a pollarded branch of a tree. Secretive and silent.

Young: From June, mostly in August. Parents loudly advertised and fiercely guarded the brown young hidden within thick bushes.

Hemipus picatus capitalis. Brownbacked Pied Shrike.

Mainly winter. Common in winter, in parties about the treetops in well-wooded parts. Sometimes hunting with other birds among shrubs. Behaviour more that of a flycatcher than a shrike. Quickly repeated whistles announced the advent of a travelling party.

Breeding: A few pairs seen through summer and rains. In May a pair evidently had a nest high up on a tree at the edge of a scrub jungle ravine. Scarce and quiet.

Young: A small family party in August.

Parties: October, parties became common.

Tephrodornis pondicerianus. Common Wood-Shrike.

Resident. Fairly common in wooded parts. Often hunting with other birds.

Breeding: May, a pair were fiercely defending a nest high up a tree in thick scrub jungle.

Pericrocotus brevirostris. Shortbilled Minivet.

Winter. Common in parties that travelled through treetops, never remaining anywhere for long, in wooded parts. Parties usually mixed, sometimes separate sexes. In March an all-male party looked delightful, hovering over and perching on tips of ripening corn in open cultivation.

Earliest seen: October 10th. Latest: end of March.

The Scarlet Minivet (*P. speciosus*) was never seen.

[' Not uncommon in the Dun and ascending the hills to about 5,000 ft.' B.B.O. EDS.]

Pericrocotus roseus. Rosy Minivet.

Summer. Not common. A solitary male, probably one of a pair, was seen on a single occasion in April in a scrub jungle ravine.

In April two years earlier, they seemed common in mixed parties at Thano a forested area further along the foothills.

Pericrocotus peregrinus. Little Minivet.

Resident. Not very common. In small parties about treetops in most types of country. Never seen hunting in company with other birds.

Breeding: Summer, seen in pairs.

Lalage melaschista. Dark-grey Cuckoo-Shrike.

Summer. Fairly common in lightly wooded parts. More often heard than seen. The call a scale of descending notes monotonously repeated uttered from an exposed perch on a treetop.

Earliest call heard: May 15th. Latest seen: September 10th. No signs of them in winter.

Breeding: Courtship: Mid-July. Pairs perched together on a tree indulging in noisy behaviour towards each other.

Graucalus javensis. Large Cuckoo-Shrike.

Mainly winter. Fairly common, singly, in pairs, or parties of up to ten, attracting attention by harsh calls. Parties often seen feeding on the ground about hedges and shrubs in open country. Always attracted by fruit trees.

Increase: Early October. Solitary or in twos and threes.

Decrease: March. Extremely few seen in summer and rains.

Largest numbers: January. Parties common.

Dicrurus macrocercus. Black Drongo.

Mainly summer and rains. Common in open country and lightly wooded parts.

Increase: March.

Decrease: From November; in reduced numbers but collecting in parties occasionally to hawk over irrigated fields. A party in January numbered over 20.

Breeding: Courtship: March, singing and aerial display. Courting hard by April.

Nesting: May to July. A nest on a garden *Terminalia* together with nesting pairs of Tree-Pie and Golden Oriole.

Young: From June. Young with short graduated tails perching on telegraph wires.

Chibia hottentotta. Haircrested Drongo.

Resident. Fairly common about wooded parts away from habitations, particuarly the tea gardens. Distinguished by larger size and longer slightly curved bill. In February attracted by flowering Silk Cotton trees.

Breeding: Courtship: March. Courting with soft fragments of song.

Young: October. A family of four or five young with short graduated tails formed a noisy party with parents among the shade trees of a tea garden.

Orthotomus sutorius. Tailor-bird.

Resident. Common everywhere except dry open country and thick forest. Sometimes in small parties.

Breeding: May to July; favourite sites in garden hedges; nests wonderfully concealed.

Cisticola juncidis. Fantail Warbler.

Not common. On March 8th a solitary bird rose out of crops and high up into the air in clicking jerks.

Franklinia gracilis. Franklin's Wren-Warbler.

Resident. Very common in winter in large parties of 30 or more in lightly wooded parts, gardens, and hedges in cultivation. Continually active following each other from bush to bush. The flock call note a *tee-tee-tee-tee-tee*.

Breeding: Courtship: April. Flocks decreased in size; individuals from exposed perches uttering a monotonous two-note chirring call.

Nesting: May to August in areas of thick cover. Secretive and shy.

Young: End of September. Small family parties.

Parties: October, gradually increasing in size.

Sylvia curruca. Lesser Whitethroat.

Mainly autumn and spring. Not very common. Solitary or in small scattered parties about scrub in open country, and along bush-fringed river banks.

Earliest seen: October 30th. Latest: End of February.

Prinia sylvatica. Jungle Wren-Warbler.

Summer. Fairly common in pairs about patches of *Zizyphus* scrub in the valley. The white outer tail feathers distinguished as they dived into cover when approached.

Breeding: Courtship: A wheezy jingle of song from a perch on the tip of a bush.

Nesting: June to July.

Earliest heard: May 31st.

Prinia inornata. Indian Wren-Warbler.

Resident. Fairly common in cultivation and open bushy parts of the valley.

Prinia socialis. Ashy Wren-Warbler.

Resident. Common in garden hedges, damp herbage, and cultivation. The lively behaviour and snapping of wings always attracted attention.

Breeding: Courtship: Conspicuously perched uttering loud challenging call notes.

Nesting: Rains.

Young: August, family parties about in herbage.

Homochlamys pallidus. Pale Bush-Warbler.

Mainly autumn and spring. Fairly common in hedges and herbage round cultivation and gardens. Skulking habits. The loud surprisingly beautiful song heard in spring attracted attention to this rather large brown warbler with a pale eyestreak and lower parts.

Seicercus xanthoschistos. Greyheaded Flycatcher-Warbler.

Winter. Fairly common, solitary or in small scattered parties with associations, hunting among trees and shrubs in most types of country.

Earliest seen: October 2nd. Latest: end of March.

Largest numbers: Autumn and spring.

Seicercus burkii. Blackbrowed Flycatcher-Warbler.

Winter. Fairly common, usually in small parties with associations in forest, scrub jungle ravines, and tea gardens. Distinguished by the yellow ring round the eye. Shyer than the last species.

Earliest seen: November 1st. Latest: April 3rd.

Largest numbers: February.

Phylloscopus inornatus. Yellowbrowed Warbler.

Winter. Common, moving with associations wherever there were trees. Constant rapid flitting about made it most difficult to get a good view of it.

Earliest seen: October 4th. Latest: April 3rd.

Largest numbers: End of March. A marked increase. Mango blossoms a great attraction.

Phylloscopus proregulus. Pallas's Willow-Warbler.

Winter. Common. In small parties hunting on their own or with an association in wooded parts. The habit of hovering before an attractive piece of foliage when the yellow rump patch was conspicuous identified it.

Earliest seen: November 16th. Latest: March 25th.
Largest numbers: February.

Phylloscopus occipitalis. Large crowned Willow-Warbler.

Winter. Fairly common in small parties often with associations, in wooded parts. The call of rapid whistles like a sunbird's.

Earliest seen: September 27th.

Oriolus kundoo. Indian Oriole.

Summer. Common about wooded parts and groves of trees in open country. With the Paradise Flycatcher, providing the most striking bird feature of the summer months.

Earliest seen: March 21st. Latest: September 28th.

Breeding: Courtship: April. In squabbling parties, chasing each other.

Nesting: End April to August. Nests often slung high on Shisham trees, sometimes in company with other birds.

Young: From July, family parties in female plumage guarded with noisy excitement.

Largest numbers: Mid-April.

Oriolus xanthornus. Blackheaded Oriole.

Winter. Fairly common. Solitary in wooded parts and groves in open country. Its presence usually announced by the only call heard here a loud *tew*! Neither seen nor heard in summer and rains. Its appearance seemed to coincide with the disappearance of *O. kundoo.*

Earliest: October 4th. Latest seen: mid-March.

Oriolus traillii. Maroon Oriole.

Winter. Not common. A few appearances each winter. Both a male and a female, separately used a garden Eucalyptus tree as a perch. Both uttered the harsh *karrr*! call as well as some melodious Oriole calls.

Earliest seen: November 20th. Latest: March 2nd—usually mid-December.

Saroglossa spiloptera. Spottedwing Stare.

Summer. Fairly common in flocks on irregular visits. A flock would spend a few hours about a patch of scrub jungle bushes or trees in flower, keeping up a 'chittering' before moving on to another patch.

Earliest seen: April 12th. Flowering trees of *Grevillea* and *Erythrina* were main attractions. No more seen till June. Latest: July 4th. The flock included several young being fed by parents.

Acridotheres tristis. Common Myna.

Resident. Very common as usual Not as fond of sewage and refuse as Jungle and Pied Mynas.

Breeding: Courtship: Early February, break up of flocks; pairs quarrelling over nest holes.

Nesting: March to September.

Young: From end of May. Families of young following parents about grassy spaces.

Flocks: October. Flocks re-formed.

Acridotheres ginginianus. Bank Myna.

Winter. Fairly common in parties in the valley, attendant on grazing cattle, or forming part of the large flock of mixed mynas hunting in irrigated fields, especially sewage.

In June a few miles away, in Dehra Dun Cantonment, they were breeding, but this area was evidently only used as winter feeding grounds ; never noted in summer.

Earliest seen : August 21st. Latest : May 7th.

Sturnopastor contra. Pied Myna.

Resident. Common round villages and damp localities. Partial to sewage irrigation of market gardens.

Breeding: April to August. Pleasant song at this time.

Flocks: September, flocks formed again.

Sturnia malabarica. Greyheaded Myna.

Summer. Fairly common in pairs and small parties in open country and lightly wooded parts. Feeding on trees in fruit, never with other mynas on the ground.

Breeding: End April to July. In holes in pipal and other large trees where other mynas also had nest holes.

Parties : Small parties from end of September.

Increase : March.

Temenuchus pagodarum. Brahminy Myna.

Summer. Common, in most types of country. Only occasionally seen in winter. Calls amusing, musical and full of character.

Increase : February, in pairs and small parties.

Decrease : End of September. Though scarce in winter, on two occasions in December large flocks were seen.

Breeding : April to August. Nest holes high up on trees. A long time was spent before deciding on a suitable hole and many pairs of other birds were driven out of theirs during the search.

Young : July 9th, the earliest family parties shepherded about lawns and open spaces.

Flocks: Mid-September.

Aethiopsar fuscus. Jungle Myna.

Resident. Common. Partial to irrigation in open country, especially sewage.

Breeding: Courtship: April, flocks broke up into pairs and small parties.

Nesting : May to July. Nests in holes in large trees, in wooded parts, particularly tea gardens ; coming freely into gardens.

Young : Mid-June, the earliest family parties out.

Flocks: Early September, flocks reformed in old haunts in open country.

Sturnus vulgaris. Starling.

Winter. Common in flocks about open cultivation, joining other mynas feeding in irrigated fields. Parties sunned themselves high up on the bare tips of trees. The plumage very dull on arrival, was glossier by January.

Earliest seen: November 6th; in full strength a week later. Latest: Mid-March (majority in February).

Ploceus philippinus. Baya Weaver-bird.

Resident. Common in open country in flocks.

Breeding: End May, males assume breeding plumage. In June they begin building in former colonies, often on *Acacia catechu* trees surrounded by *Zizyphus* scrub.

Nesting: July to August, joint occupation of nests with females. In September, cocks renewed building activities, but these nests appeared to remain vacant or unfinished.

Flocks: End October, large compact flocks, mostly with traces of yellow about the head and neck, remained in the vicinity of their colonies.

Uroloncha malabarica. Whitethroated Munia.

Resident. Common in open country, short scrub, and edges of light forest.

Breeding: Chiefly in the rains.

Parties: In winter.

Amandava amandava. Red Avadavat or Waxbill.

Resident. Fairly common in small flocks in open country about patches of *Zizyphus* near the river banks.

Breeding: From November, the males in full breeding plumage.

Uroloncha punctulata. Spotted Munia.

Resident. Common in open country, about hedges; attendant on ripening crops.

Breeding: Courtship: June, in pairs, males often perching on tips of bushes to 'sing'.

Nesting: July to September, in scrub jungle and more wooded parts. Nests often placed in dense garden shrubs and creepers. Both sexes very busy and quick at building. Many nests were built and deserted.

Young: From August, small family parties.

Flocks: November, full sized flocks in usual haunts.

Capodacus erythrinus. Common Rosefinch.

Mainly autumn and spring. Common in spring about ripe crops and flowering trees, in cultivation, gardens, and scrub jungle. Often seen in flight holding a flower by the base.

Autumn Passage: Earliest seen: September 13th, flocks almost entirely in female plumage feeding on ripening jowar crops.

Scarce between December and February.

Spring Passage: Earliest increase: March 25th, a sharp increase within a few days. Flocks in male plumage arrived first, and were joined by those in female plumage. Ripe wheat and oat crops, flowers of *Grevillea*, *Woodfordia*, and *Adhatoda vasica* were the main attractions.

Latest seen: May 7th. (majority mid-April). The last flocks about *Woodfordia* in scrub jungle, consisted of birds all having red throat patches, with otherwise female plumage.

Carduelis caniceps. Himalayan Goldfinch.

Spring. Common some years, scarce in others. In parties about seeding garden plants, sometimes concentrating on a certain clump till it was demolished.

Earliest seen: February 22nd. Latest: Mid-April.

Largest numbers: End March 1950, many parties were operating in different gardens.

Hypacanthis spinoides. Himalayan Greenfinch.

Winter. Fairly common in flocks, about hedges in cultivation, feeding in fallow fields often with other finches. The flight in close-packed formation distinctive. At least one of the party was usually perched on some high vantage point singing, while the rest foraged on the ground.

Earliest seen: November 1st. Latest: January 11th.

Metaponia pusilla. Goldfronted Finch.

Spring. A flock took up residence for a short time every year in the market gardens. It split up into parties feeding on the ground among the vegetable and wild flower seeds, especially *Ageratum.* The red gold patch on the forehead of the male, the close formation during the short wheeling flights from one patch of ground to another, the way of alighting simultaneously on the bare tips of a tree were distinctive.

Earliest seen: February 1st. Latest: April 2nd. Some years the flock only remained there about a fortnight.

Gymnorhis xanthocollis. Yellowthroated Sparrow.

Summer. Common in open country and lightly wooded parts. Never seen in winter.

Earliest seen: March 17th. Arrived in flocks feeding in fallow fields. Latest; July 18th. The departure was always sudden.

Breeding: April to June. Flocks broke up, and pairs established nest holes high up on trees. One of the pair generally perched close by the nest chirping monotonously.

Flocks: Early July, in large flocks, the numbers greatly increased.

Passer domesticus. House Sparrow.

Resident. Common and unobtrusive about habitations, and in flocks in cultivation.

From April 30th to May 4th a large and entirely male flock fed in the market gardens.

From July 10th to mid-August, a large flock all in female plumage fed on newly germinated rice in the same locality.

Breeding: March to June chiefly; the empty nests of the Cliff Swallow colony were made good use of when they were not in residence.

Passer rutilans. Cinnamon Sparrow.

Winter. Fairly common in large flocks of mixed sexes. Not near habitations as in Mussoorie, but with headquarters in hedges in cultivation. The loud communal chirping could be heard at a distance.

Earliest seen: November 5th. Latest: March 19th. Plumage of males much brighter.

Largest numbers: February.

Emberiza stewarti. Whitecapped Bunting.

Winter. Common in flocks in open country and edges of light forest. When not feeding on the ground they rested hidden within the foliage of trees and shrubs.

Earliest seen: November 14th. Crowns grey. Latest: end April. Crowns nearly white.

Largest numbers: January and February.

Another Bunting common about the same time was probably the Greyheaded Bunting, *E. fucata.*

Emberiza cia. Eastern Meadow Bunting.

Spring. Not common. Occasional small parties about the valley near cultivation.

Earliest seen: February. Latest: early March.

Emberiza melanocephala. Blackheaded Bunting.

Spring. Not common. At the end of April 1947, a small flock was about a patch of ripe unharvested crop. They were probably on passage and were not seen again.

Melophus lathami. Crested Bunting.

Mainly winter. Fairly common in open cultivation and patches of 'jherberi' (*Zizyphus*) near river beds. Usually in small mixed parties.

Earliest seen: September 13th. Latest: May 18th. On one occasion on May 31st, a pair, one of which was singing, were probably breeding.

Largest numbers: February.

Hirundo smithii. Wiretailed Swallow.

Mainly summer. Common in pairs, hawking with other swallows, flapping in and out of bungalow verandahs and perching on their sheltered ledges.

Earliest seen: mid-April. Latest: mid-December. Majority at end of rains.

Breeding: May to July, nests very often placed on inner ledges of verandah pillars.

Young: July, the earliest family parties hawked in the vicinity of the home buildings and rested in the nest at night.

Riparia concolor. Dusky Crag Martin.

Resident. Not common. Two or three pairs resident about the building of the Forest Research Institute.

Riparia rupestris. Crag Martin.

Spring. Not common. In small flocks, hawking over the remaining water of the Tons and Nimi rivers, swooping right down to touch the scarcely running waters and wheeling away at great speed to concentrate on another stretch. The larger size and white spots on the dark tail feathers were distinctive.

Earliest seen: January 18th. Latest: March 10th.

Riparia paludicola. Indian Sand Martin.

Resident. Common, in pairs and small flocks about the river banks of the valley.

Breeding: November to January chiefly. Holes in the banks were often in solitary positions as well as in colonies.

Hirundo fluvicola. Cliff Swallow.

Spring and autumn. A large flock had a permanent colony of nests along the underside of an overhanging ledge on the roof of the F.R.I. building. The flock worked collectively in everything, collecting mud pellets from a stream ¼ mile away, hawking high above the building when not attending to nests.

Breeding: Two seasons. February 22nd to rains. September 16th to November [?]

Great excitement and chittering prevailed round nests; each bird appeared to attend to several of them.

Hirundo daurica. Striated Swallow.

Mainly summer. Common in pairs and flocks, hawking over damp areas.

Increase: Early February, arriving in pairs and small parties. Decrease: Mid-December, very few remained.

Breeding: Courtship; February, pairs circled overhead singing.

Nesting: March to August. Nests placed on roofs of buildings under ledges. Rearing of young and completing of the neck of the retort-shaped nest ran concurrently in one case.

Young: Family parties perched close together by day, and roosted in the nest at night.

Flocks: September–October. Large flocks collected on telegraph wires, etc. Early mornings and evenings the sky filled with their fluttering forms.[1]

Motacilla alba. White wagtail.

Winter. Common in parties large and small about damp parts and open grassy spaces, some solitary.

Earliest seen: August 31st. Common a month later. Latest: April 30th; majority in February.

Motacilla maderaspatensis. Large Pied Wagtail.

Rains and Winter. A few pairs about the river and market gardens, sometimes with other wagtails.

Departed as the river dried up, and reappeared at the beginning of the rains.

Earliest seen: June 22nd.

Motacilla cinerea. Grey Wagtail.

Winter. Common. Solitary or in pairs near any kind of water.

Earliest seen: August 31st. Often arriving in small parties. Common by September 10th. Latest: April 27th. Generally in pairs.

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[1] These are winter immigrants of the race *nipalensis*. EDS.

Motacilla flava. Yellow Wagtail.

Winter. Common in flocks in the valley in attendance on grazing cattle, or with other wagtails in irrigated fields. Not so common between autumn and spring.

Earliest seen : September 9th. Plumage dull and very varied. Largest numbers : end February. Latest seen : May 22nd ; majority April. Yellow parts of the plumage bright. The last parties appeared to be the Blueheaded Wagtail (*M. f. beema*).

Motacilla citreola. Yellowheaded Wagtail.

Winter. Not common. A few with the whole head yellow occasionally seen with other wagtails along the river beds.

Earliest : November 12th.

Anthus hodgsoni. Indian Tree Pipit.

Winter. Common in parties feeding on the ground under trees in gardens and lightly wooded parts.

Earliest seen : September 15th. Latest : May 7th (majority end April).

Largest numbers : April.

Anthus trivialis. Tree Pipit.

Spring. Common in flocks in open cultivation, especially the market gardens. Greyer than the last. Feeding on the ground and flying up on to the bare tips of trees.

Earliest seen : February 1st. Latest : end April.

Largest numbers : end March, a large increase.

Anthus roseatus. Hodgson's Pipit.

Another pipit, common in flocks in winter, feeding in damp parts of open cultivation, was dark in general colour with a heavily streaked breast. One caught bird had a few thin feathers under the wing (axillaries) bright yellow.

Anthus rufulus. Indian Pipit.

Resident. Fairly common. In pairs on open grassy places and fallow fields.

Breeding : Judging from their agitated behaviour, a pair were evidently nesting, or had young in a fallow field. May 20th.

Alauda gulgula. Little Skylark.

Resident. Fairly common about the fallow fields and dry grassy parts of the valley.

Breeding : Courtship : End April, singing and soaring.
Nesting : June to September.

Alauda arvensis. Skylark.

Winter. Fairly common in small flocks, feeding on the ground between the young wheat plants, in open cultivation.

Earliest seen : November.

Galerida cristata. Crested Lark.

Resident. Fairly common, small scattered parties, about patches of *Zizyphus*, and stony sandy surrounds of the rivers. A clear, pleasant song.

Breeding: Courtship: March, hovering high and singing.

Nesting: April to August. Nests built into the base of *Zizyphus* bushes.

Young: May. A family of 3 young in a nest resembled a large striped toad as they 'froze' with bills pressed together.

Eremopteryx grisea. Ashycrowned Finch-Lark.

Resident. Common in open dry parts of the valley and river beds. Running and squatting among the boulders.

Breeding: Courtship: March, males singing in soaring flight, diving with the whistling sound of air forced through wing feathers.

Nesting: April to September.

Flocks: October.

Zosterops palpebrosa. White-eye.

Resident. Common about all lightly wooded parts and regular attendants on all flowering shrubs and trees.

Breeding: Courtship: April, perched solitary and singing a song that began softly and became louder.

Nesting: April to August. Most nests slung very low down on shrubs in thick scrub jungle. Parents were shy and left the eggs exposed for long periods.

Parties: September, small parties which increased in size to large ones. They generally formed the nucleus of the hunting associations of small birds for the winter.

Aethopyga siparaja. Yellowbacked Sunbird.

Resident. Fairly common about gardens and light forest. The shrub *Hamelia patens*, in flower nearly throughout the year, was much favoured, and the corollas of *Russelia juncea* were regularly pierced by their bills. The yellow on the back never seemed to be visible. Comparatively few males in full plumage; many in female plumage with red throat-patches.

Breeding: In September, a female had been very busy pulling fine strips off cane chairs and plant stems on the veranda.

These were woven into a nest slung under the thick canopy of foliage overhanging a ravine. The male appeared to take no part in construction but was in the vicinity. The nest was never used.

Aethopyga ignicauda. Mrs. Gould s Yellowbacked Sunbird.

Winter. Not common. On December 5th, in scrub jungle, solitary in female plumage. The identity marks, yellow underparts, purple tail, red patches on scapulars. The head, upper back, throat, and upper breast olive-green.

Cinnyris asiaticus. Purple Sunbird.

Summer. Common.

Earliest seen: January 21st. Majority end February. Males arrived in breeding plumage, and visited the flowers of *Adhatoda vasica*. Latest seen: September.

Breeding: Courtship: Excited chases by males.

Nesting: March to July. Seed down of the creeper *Cryptolepis buchanani* eagerly collected for nest lining.

Piprisoma agile. Thickbilled Flowerpecker.

Resident. Fairly common. Solitary or in pairs, high up on trees attendant on parasitic plants.

Breeding: About March to June.

Dicaeum ignipectus. Firebreasted Flowerpecker.

Resident. Not common. Always seen on the creamy white flowers of the parasite *Loranthus pulverulentus.* Flitting actively about with constant *chick! chick! chick!* The male conspicuous with the orange-scarlet patch on the breast, central dark line below it running down the abdomen, and blue-black upper parts.

Earliest seen: Mid-November. Latest: February 22nd.

Pitta brachyura. Indian Pitta.

Summer. Not common. Occasionally seen in scrub jungle, hopping through the dead leaves under thick cover.

Earliest seen: May 21st. Latest: September.

Brachypternus benghalensis. Goldenbacked Woodpecker.

Resident. Fairly common, solitary or in pairs wherever there were tall trees, in the tea gardens specially.

Breeding: Courtship: March. 'Drumming' heard.

Nesting: March to July. One nest in open country had the entrance-hole on the underside of a low horizontal branch.

Chrysocolaptes guttacristatus. Crimsonbacked Woodpecker.

Probably resident. Not common. In April, in the market gardens a party of three were working at the large trees, moving from one to another in company with Jungle Babblers. In flight the red rump was conspicuous.

Breeding: April 6th, a solitary bird was 'drumming'.

Dryobates auriceps. Brownfronted Pied Woodpecker.

Resident. Fairly common in the tea gardens. Sometimes with hunting associations of small birds in winter.

Breeding: Courtship: 'Drumming' in April.

Nesting: April and May.

Iynx torquilla. Wryneck.

Autumn and spring. Not common. Occasionally seen among bushes in open country.

Earliest seen: September 24th. Latest: April 17th.

Megalaima virens marshallorum. Great Himalayan Barbet.

Spring. Not common. In 1947, a small scattered party established headquarters in scrub jungle ravines, and visited adjacent gardens, where the berries of *Duranta* hedges were an attraction. Not seen at all other years.

Earliest seen: January 21st. Latest: mid-March.

Megalaima asiatica. Bluethroated Barbet.

Winter. Not common. Occasionally seen solitary high up on trees at fringes of scrub jungle ravines.

Earliest seen: November 26th. Latest: March 15th.

Megalaima zeylanicus. Green Barbet.

Resident. Common, solitary or in pairs in wooded parts and large trees in open country, particularly trees in fruit. Subdued in winter.

Breeding: Courtship: February. Pairs started calling to each other. Calling in full strength by end of the month.

September and October, a renewed burst of calling.

Nesting: March to June.

Megalaima haemacephala. Coppersmith.

Resident. Fairly common, but not as much so as *M. zeylanicus.* The metallic *toonk* call was never such a feature of early hot weather as in the plains.

Breeding: Courtship: End January; the call became more noticeable and gathered strength in February.

Nesting: February to June.

Young: June 19th, the earliest out of nest.

Parties: January, sometimes quite large parties formed to feed on fruiting trees, particularly of the fig family.

Coracias benghalensis. Indian Roller.

Resident. Common wherever there were trees, except thicker wooded parts. Mostly in defined territories.

Breeding: Courtship: May, the chief time for displays, and noisy behaviour.

Nesting: May to August. One pair used a bungalow chimney; usually the holes in large pipal trees about the valley.

Young: July, hunting independently and mewing like kittens.

Merops orientalis. Green Bee-Eater.

Mainly summer. Common everywhere except in thickly wooded parts. Scarce in winter.

Earliest increase: February 24th, arriving in large excited flocks.

A slight decrease in numbers soon followed, when probably those bound for further parts passed on.

Decrease: Mid-October, only an occasional small party seen after this, visiting gardens and wooded parts.

Breeding: Courtship: March. Though in scattered flocks, pairs perched close together, indulged in flirtations.

Nesting: April to June. The holes solitary and well concealed, comparatively few in river banks. One or both parents hunting from low fixed perches in vicinity of nest.

Young: June, the earliest grown young out hawking, their throats pale instead of blue.

Flocks: Mid-June, large roosting flights collected in the evenings.

Merops superciliosus. Bluetailed Bee-Eater.

Summer. Common in flocks, with headquarters near the nesting colonies on river banks.

Earliest seen : April 2nd, arriving in pairs and small parties to vicinity of old nesting sites. Large increase within a fortnight to form flocks. Latest : end September. Numbers gradually reduced.

Breeding : April to June. Much prospecting of old nests before fresh excavations began. The colony of nest-holes in the soft earth of low river banks. When not occupied at the nest, the birds squatted on boulder below.

Parties : Mid-June. Family parties hawked away from breeding sites over gardens and edges of forest.

Alcemerops athertoni. Bluebearded Bee-Eater.

Resident. Fairly common. Usually in pairs about thick scrub jungle ravines and well wooded parts. They attracted attention by deep-throated croaks and chortles, and general quaint behaviour towards each other as though continually indulging in courtship.

Breeding : May and June. In nest-holes in the perpendicular faces of a bank along a path through thick scrub jungle.

Nest-holes of several years quite close together. Both parents fed the young, and were not shy at this time of observation. The usual debris of insect chitin scattered on the floor of the entrance.

Ceryle rudis. Indian Pied Kingfisher.

Rains. Not very common. Pairs or small parties over the rivers when there was sufficient water, crouching on the boulders at the edges of streams. As the river dried they probably moved to more permanent water only a few miles away.

Earliest seen : July 7th.

Halcyon smyrnensis. Whitebreasted Kingfisher.

Resident. Common, holding territories in gardens and open country. From garden ponds, small fish including gold fish were often captured.

Breeding : Courtship : March, much harsh screaming *kiri*, *kiri* interspersed with short *chip* ! *chip* ! from high perches and on chasing flights.

Nesting. April to July. Large holes (tunnels) in high perpendicular banks of jungle ravines.

Alcedo atthis. Common Kingfisher.

Rains and winter. Fairly common, solitary or in pairs along stretches of river where there was water.

Earliest seen : August 20th.

Tockus birostris. Grey Hornbill.

Mainly rains and winter. Common in wooded parts and visiting trees in cultivation, particularly trees in fruit. Sailing after each other from tree to tree, with weird calls, behaving in an uncouth and amusing manner.

Breeding : February to mid-May. A very few pairs seen during this time.

Young: Mid-May, small parties probably family ones, occasionally seen.

Parties: August, increasing in size as winter progressed.

Upupa epops. Hoopoe.

Mainly summer. Common, favouring the neighbourhood of dwellings. Rather scarce in winter.

Increase: January. Decrease: October.

Breeding: Courtship: End January, the *hoo-poo-poo* calls subdued to begin with strengthened and heard coming from all directions with ventriloquial effect.

Nesting: February to June. Favourite sites for nests, the ventilating and other holes on the undersides of roofs of buildings and village huts.

Young: April. In May many families of young being fed to the accompaniment of shrill chitterings of parents.

Parties: End August; parties of up to 17.

Micropus affinis. Indian Swift.

Mainly summer. Common in pairs and flocks about dwellings, very few remained through winter.

Earliest seen: February 14th, in small parties that increased in size. Latest: end October for the majority.

Breeding: March to September. Besides the usual colonies under eaves, many single nests were built high up on inside corners of house verandahs.

Micropus melba. Alpine Swift.

Rains. Not common. Occasionally two or three were hawking overhead with a party of Indian Swifts, distinguished from them by the much larger size, pale underparts, except for a dark band across the breast, and the extra speed and dexterity in flight.

Earliest seen: July. Latest: September.

Caprimulgus macrurus. Horsfield's Nightjar.

Resident. Commonly heard in summer from the scrub jungle ravines, from where the remarkable deep *chonk! chonk! chonk!* resounded after dark.

Earliest call heard: February 25th.

Breeding: Courtship: March, the mating calls continued with intervals from dark to dawn. Less calling in April, then silent.

Parties: October, about a dozen nightjars (species ?) hawked over a ravine at dusk.

There were two or three other nightjar calls, and birds were often flushed from the bases of shrubs or seen in rapid flight in the early evenings.

Cuculus canorus. Cuckoo.

Summer. Fairly common, usually seen in rapid flight between large trees in open country. Arrivals and departures were punctual.

Earliest heard: April 13th. Latest: end July.

Breeding: Courtship: Pairs or trios chasing each other with vigorous calls.

Cuculus micropterus. Indian Cuckoo.

Summer. Common in more wooded parts. The call locally described as *lost my rifle!* was often uttered in flight and became a feature of the season.

Earliest call heard: April 7th, subdued to begin with and only at dawn and dusk. Latest: end July.

Breeding: Courtship: End April, pairs calling in chasing flight, and displays while perched close together on a branch. Calls heard all night as well as day, particularly moonlight nights.

Hierococcyx varius. Common Hawk-Cuckoo.

Summer. Common wherever there were trees.

Earliest heard: February 18th, early calls very soft and short. Latest: end September.

Breeding: Courtship: Early April, the peak period of shrieking day and night. Subdued by May; only occasionally heard in August.

Surniculus lugubris. Drongo-Cuckoo.

Summer. Fairly common in wooded parts. Favouring fixed perches usually well exposed on bare tips of large trees overlooking scrub jungle ravines. Thus perched in a 'humped up' attitude, a seemingly endless repetition of the usual call of five or six notes in an ascending scale is indulged in. The other call, like a shrill version of the beginning of the 'brain fever' call without the 'brain fever' part, was also heard accompanied by a lifting of both wings to touch above the back. Earliest heard: April 15th; the first bird calls in the early mornings. Latest: September 16th. The second type of call mostly heard in August.

Breeding: Courtship: Early May to June, calling at night as well as by day, often beginning about 9 p.m.

Cacomantis passerinus. Plaintive Cuckoo.

Rains. Not very common.

Usually heard calling from large trees in open country. Besides the *caweeer!* call, there was an attractive lilting one.

Earliest heard: June 19th. Latest: September 13th.

Clamator jacobinus. Pied Crested Cuckoo.

Rains. Fairly common in pairs about cultivation and wooded parts.

Earliest heard: June 6th. Latest: October 5th; majority end of September.

Breeding: Courtship: Pairs noisily chased each other on arrival.

Taccocua leschenaultii. Sirkeer Cuckoo.

Resident. Fairly common but inconspicuous till the orange bill was spotted at the edge of scrub jungle ravines or hedges in cultivation.

Breeding: Courtship: Mid-March, perched high, one was calling a series of deep throaty sounds.

Eudynamis scolopaceus. Koel.

Summer. Common, usually seen in pairs. Often feeding on fruiting trees, the berries of *Cinnamomum camphora* favoured.

Earliest call heard : March 24th ; first calls gentle, only early mornings. End April, calling full strength. Latest heard : end October; the last of the cuckoos.

Centropus sinensis. Common Crow-Pheasant.

Resident. Fairly common, usually solitary in gardens and bushy parts of damp cultivation.

Breeding : Courtship : Pairs, calling the deep *hood* call frequently heard, and from a high perch the deep, descending *cock, cock.*

Young : Early October.

Psittacula eupatria. Large Indian Parakeet.

Resident ? Not common. In August, a party fed on fruiting trees in a garden. Small parties of parakeets which seemed large sometimes seen in the distance throughout the year.

Psittacula krameri. Green Parakeet.

Resident. Common in flocks which were smaller than those usual in in the plains. In gardens and open country wherever there were ripe crops or trees in flower or fruit.

Breeding : January to May. The large shade trees of tea gardens favoured for nest holes.

Young : March, parties in flight with tailless young.

Flocks : Mid-August, the regular morning and evening flights between roosts and feeding grounds began.

Psittacula cyanocephala. Blossomheaded Parakeet.

Resident. Common in small flocks about the same feeding grounds as *P. krameri*, but not mixing with them. Distinguished at a distance by the lighter and prettier calls.

Breeding : February to May. They did not seem to use the trees of the tea gardens, and were still seen in small parties during this time.

Young : Early April. Quite large flocks in June consisting entirely of tailless young fed on the flowers of *Cannabis sativa*, ' Bhang '.

Flocks : October. Large flocks on jowar crops and trees in flower and fruit.

Psittacula himalayana. Slatyheaded Parakeet.

Winter. Common in flocks in gardens and other lightly wooded parts. The flocks stayed some time in one area, before moving to another. Besides excited calls *scree! scree!* a long drawn out *weeeenge!* was a flock call as they fed scattered about a group of trees. Special attractions were berries of *Duranta* hedges, camphor berries, the russet seeds of *Terminalis myriocarpa*, flowers of *Bauhinia purpurea*, and in February the dry pods of Shisham (*Dalbergia*).

Earliest seen : September 15th. Latest : March 16th, majority in February. Heard April 4th.

Otus sunia. Scops Owl.

Summer. Commonly heard in summer, endlessly repeating its *kwuk-kuck-kuk* after dark.

Calls : March to June. In full strength in May. Silent by July.

Athene brama. Spotted Owlet.

Resident. Common and to be seen at all times of the day. Pairs and family parties with permanent homes in big trees.

Breeding: March to May. Chimneys of bungalow sometimes used for nest holes.

Young: August. Many family parties of young about.

Parties: In February, a party of over 20 had collected to prey on emerging winged termites in the valley.

Glaucidium radiatum. Jungle Owlet.

Resident. Fairly common; occasionally seen in daylight perched very still and quiet at the edge of jungle ravines. Distinguished by the general dark chestnut colour and very close barring.

Glaucidium brodiei. Pigmy Collared Owlet.

Winter. Not common. December 8th, New Forest—a solitary bird flushed from thick undergrowth. A bell-like four-noted whistle was made as it rose to perch on an exposed branch to show its diminutive size.

Ninox scutulata. Brown Hawk-Owl.

Summer. Not common. The call *kwoo-wup!* deep noted, repeated at fairly long intervals, was heard every year from the small group of trees in the Defence Academy grounds after dark.

Calls: March to May.

Sarcogyps calvus. King Vulture.

Resident. Fairly common. Most often seen sailing high overhead solitary or in pairs. The large white patches on the flanks very prominent.

Pseudogyps bengalensis. Whitebacked Vulture.

Resident. The common vulture in all parts of the area.

Breeding: Appeared to go on throughout the year.

Courtship: Displays in flight and over nest, where mating was was accompanied by loud braying noises. Chiefly in February, and again from June to October.

Nesting: In September a pair set up a nest high on top of a banyan tree in the Academy area. It was their headquarters throughout the year. By the next September, it had become a colony of four nests.

? Gyps fulvus. Griffon Vulture.

Resident. Not common. Occasionally noted at all seasons of the year in flight with other vultures.

Gyps himalayensis. Himalayan Griffon Vulture.

Winter. Not common; very occasionally seen in flight overhead in early winter. Distinguished by its larger size from *G. fulvus.*

Earliest seen: October 24th.

Neophron percnopterus. White Scavenger Vulture.

Resident. Common wherever there was refuse.

Breeding: Early summer.

Young: April, many in brown and varying stages of brown and white immature plumage.

Gypaëtus barbatus. Lämmergeier.

Winter. Not common. Very occasional appearances in flight or perched on a tall tree.

Earliest seen: October 31st; latest: January 13th.

Astur badius. Shikra.

Resident. Fairly common in all wooded parts and groves in open country. Usually noticed when causing consternation among other birds.

Accipter virgatus. Besra Sparrow Hawk.

Winter. Not common. In September a pair chased each other from tree to tree with loud cries of *ki-weer*! Though in open country, they kept along the edge of jungle covered cliffs. The dark stripe down the centre of the throat was distinct.

Haliastur indus. Brahminy Kite.

Rains. Not very common. Only noticed in the area during the rains, in pairs perching on trees over flooded rice fields near the river, their behaviour and calls as though courting. They were resident on the Asan River only a few miles away.

Earliest seen: July 12th. Latest seen: October 12th.

Milvus migrans. Common Pariah Kite.

Resident. Common, but not noisy.

Breeding: January to May.

Flocks: Often collected in numbers over an emergence of winged termites. In August, large flocks collected to feed on the ground on open grassy spaces such as playing fields, often all facing the same way. In September, numbers flew off in a common direction at roosting time.

Milvus m. lineatus, the Large Indian Kite, was probably the rather larger Kite with paler wing patches sometimes seen in open country in winter.

Elanus caeruleus vociferus. Blackwinged Kite.

Not common. On a few occasions in April and May, pairs were seen in the market gardens, probably the same pair. In September, while one attacked a kite, the other on a tree shrieked *tiewe*!, *tiewe*! while lifting the wings high above the back.

Circus aeruginosus. Marsh Harrier.

Winter. Not common. Only one adult male and a few in female plumage in slow watchful flight low over swampy patches in the market gardens, or rising out of irrigated fields of standing crops.

Earliest seen: July 28th. Latest: December.

Falco peregrinator. Shahin Falcon.

Winter. Not common. Occasionally seen solitary perched high on a bare tip of a tree in wooded parts or open country. The cheeks showed up as square black patches.

Earliest seen: November 24th.

Falco chicquera. Redheaded Merlin.

Winter. Not common. Occasionally seen in flight or perched on a tall tree in open country. Once observed persecuting a Tawny Eagle.
Earliest seen: December 6th.

Spilornis cheela. Indian Crested Serpent Eagle.

Resident. Fairly common in well-wooded parts, especially the tea gardens. Sometimes solitary or in flight above cultivated fields when the barred rounded wings were distinctive.

Breeding: Courtship: February, much calling and display in flight.

Aquila nipalensis [or **rapax** ?] Steppe [or Tawny ?] Eagle.

Winter. Fairly common. Only noticed in this area in winter, solitary or in separated pairs perched on tall trees in open country.

Breeding: Courtship: November to February, while soaring high with loud noises.

Nesting: In November, one sat on a nest high up on a tall pipal tree in open country.

Aquila heliaca. Imperial Eagle.

Winter. Not common, but a few came regularly to the valley. A certain tree was the favourite perch for one of a pair for three winters. No two birds seemed to be in the stage of plumage. Distinguishing features besides being very large and dark, were the pale cream head and white rump patch. In general appearance and flight like a vulture.
Earliest seen: December 7th; Latest: end March.

Several other eagles were winter visitors. Among them a very large one with two broad pale wing bars, probably the Steppe Eagle, and another all white below with fine dark stripes, Bonelli's Eagle ?

Buteo rufinus. Longlegged Buzzard.

Winter. Fairly common. Came regularly to the valley, particularly the market gardens, where perches on the same trees were used yearly. Varying amounts of white on head and neck, and rufous on breast. They allowed a close approach.
Earliest seen: October 12th. Latest seen: March 20th.

Butastur teesa. White-eyed Buzzard.

Resident. Fairly common in open country. Generally solitary perched on tops of trees standing in cultivation. The white patch on the nape conspicuous.

Crocopus phoenicopterus. Common Green Pigeon.

Resident. Not very common, small flocks sometimes seen in flight or perched high on trees both in open country and wooded parts.

Breeding: June, seen in pairs.

Flocks: July to January.

Chalcophaps indica. Emerald Dove.

Resident. Fairly common in thick scrub jungle ravines, coming from there into gardens and surrounding open spaces to feed on the ground, or crossing in low direct flight, the head held high.

Breeding: Courtship: May to August, the deep dreamy *hoo* was heard coming from the thickest cover of ravines. Silent by September.

Columba livia. Blue Rock-pigeon.

Resident. Common, but erratic in numbers. A colony had permanent headquarters on the F. R. I. building.

In July and August, small parties collected into large flocks and fed on fallow fields and fields being prepared for rice cultivation in the market gardens. Regular morning and evening flights to and from this feeding ground at that time.

Streptopelia orientalis. Rufous Turtle Dove.

Mainly spring. Fairly common in small parties of two to six, feeding quietly on lawns, or in open cultivation with other doves. The belly of this race being white, it was probably the race *S. o. meena.*

Earliest seen: July 28th. Largest numbers: February. Latest seen: March.

Streptopelia chinensis. Spotted Dove.

Resident. Common in all types of country chiefly open cultivation. In pairs and flocks.

Breeding: Courtship: From February, *ku-kroo-ku* as a mating call heard increasingly from birds in pairs, though they still collected in scattered parties.

Flocks: November, large flocks in cultivation.

Streptopelia senegalensis. Little Brown Dove.

Resident. Common, usually in pairs feeding on grassy spaces near buildings, allowing a near approach.

Breeding: Courtship: February, the *coo-coo-coo-coo* calls became insistent.

Streptopelia decaocto. Indian Ring Dove.

Mainly winter. Common in winter in large flocks about open cultivation. Comparatively few in summer.

Breeding: Courtship: From February, in reduced numbers. Mating calls *coo-coo-coo* and 'mewing' with displays in flight.

Nesting: March to October.

Flocks: October, large increase November to January.

Oenopopelia tranquebarica. Red Turtle Dove.

Mainly summer. Common in parties and pairs in open cultivation and roadside trees.

Increase: in April. Decrease: September. Practically none seen between November and February.

Breeding: Courtship: March, the 'water boiling' calls from the male on a high perch.

Nesting: April to July. In June a pair were incubating high up on a garden Shisham tree.

Young: Early June, the first young about.

Gallus gallus. Red Junglefowl.

Resident. Fairly common in the thick scrub jungle ravines. When undisturbed, parties came up to the gardens to feed.

Breeding: Courtship: End February to mid-July, the cocks crowing loudly in the early mornings.

Pavo cristatus. Peafowl.

Not common due to persecution. In December a small party were in thick cover in the Gaulaita valley.

Gennaeus leucomelanus hamiltonii. Whitecrested Kalij Pheasant.

Probably resident. Not common. Once seen and sometimes heard in the same stretch of thick scrub jungle ravines. When disturbed the squealings were pig-like. Heard in all seasons, but mostly in April.

Perdicula asiatica. Jungle Bush-Quail.

Resident. The common quail of the area. In small coveys and pairs, flushed from hedges and scrub in cultivation and scrub covered slopes.

Breeding: In September the coveys included young ones.

Turnix sylvatica. Little Button-Quail.

Winter? Not common. On October 27th, a covey was feeding in a ripe rice crop.

Francolinus pondicerianus. Grey Partridge.

Resident: Common in open bushy country. When flushed, usually flew up to perch on trees.

Breeding; End February, pairs separated from coveys.
Nesting: April to June.
Young: In August, the coveys included young.
Coveys: From September in full strength.

Francolinus francolinus. Black Partridge.

Resident? Not common. In May, a male and probably also a female, accompanied by several chickens, came every evening for some days from the scrub jungle ravines, to feed and drink at the edge of a garden.

Burhinus oedicnemus. Indian Stone Curlew.

Resident. Not very common. A few were usually to be found about the dry river bed of the Gaulaita river valley, only occasionally appearing in other dry open parts of the valley. Besides running and 'freezing', they flew fairly high. When disturbed with a cry reminiscent of a seagull.

Breeding: March, in pairs.

Parties: Winter, pairs collected into small parties.

Esacus recurvirostris. Large Goggle-eyed Plover.

Not common. On December 21st, a pair were on the dry Tons river bed, moving warily about. In flight the resemblance to a duck was striking.

Lobivanellus indicus. Redwattled Lapwing.

Resident. Common, about damper parts of cultivation.

Breeding: March to August.

Parties: Parties of up to 20 scattered about the sewage irrigation of the market gardens. October to January.

Lobipluvia malabarica. Yellow-wattled Lapwing.

Resident. Not common. An occasional pair seen about the dry stony cultivated parts of the valley.

Breeding: June. Judging from their behaviour, a pair evidently had a nest or young close by on a dry stony field.

Microsarcops cinereus. Greyheaded Plover.

Winter. Not common. In December, a solitary bird was with a party of Redwattled Lapwings about the sewage irrigation of the market gardens, remaining with them about a month. Conspicuous among the others with its grey-brown head and neck and breast. Neither did it always fly with them when flushed, often remaining still as though conscious of its good camouflage.

Earliest seen: December 21st. Latest: January 19th.

Hoplopterus duvaucelli. Spurwinged Plover.

Winter. Not common. An occasional pair among the stones of the dry river bed. In January a small party was with Redwattled Lapwings about a sewage swamp in the market gardens. When disturbed, they made straight for the river bed where they seemed much more at home.

Earliest seen: October 23rd, usually December. Latest: January 15th.

Charadrius jerdoni. Little Ring Plover.

Mainly winter. Common in parties running about the edges of river, streams, and pools. As the river dried up, the majority departed.

Breeding: Courtship: February and again in October, pairs chasing each other, beating up and down the same small area in flight, uttering a quickly repeated clear whistle.

July to August—a few remaining pairs, seen throughout this period.

Parties: October.

Leucopolius alexandrinus. Kentish Plover.

Winter. Not common. On November 11th, two were with a party of Little Ring Plover feeding beside a stream of the river. The pale brown coloration, absence of any black face marking except for the black eye and bill, and no black breast band distinguished it from the others. It may possibly have been a form of immature plumage of the Little Ring Plover.

Tringa hypoleucos. Common Sandpiper.

Winter. Common along the edges of river-streams, occasionally at the sewage swamp. Usually in pairs.

Earliest seen: August 20th. Largest numbers: September. Latest seen: April 29th.

Tringa ochropus. Green Sandpiper.

Winter. Common, especially on autumn and spring passage, about sewage swamps and pools of stagnant water as well as river streams.

Earliest seen: July 10th, usually mid-August. Largest numbers: early September, often in small parties. Latest seen: April 21st. In March, the return passage is noticeable.

Tringa glareola. Wood Sandpiper.

Winter. Fairly common in small parties, at the edges of sewage swamps and river streams. Distinguished by the visible spots on paler brown plumage.

Earliest seen: September 24th.

Erolia temminckii. Temminck's Stint.

Autumn. Fairly common in parties that rapidly increased, then gradually decreased in size, at edges of river streams and the sewage swamps. When in flight in close formation, the white outer tail feathers were visible.

Earliest seen: September 4th. Latest: end of October.

Gallinago sp. Snipe.

Autumn Not very common. An occasional solo, flushed from damp parts of the valley, may have been the Eastern Solitary Snipe, *G. solitaria.*

Earliest seen: August 26th. Latest: November.

Rostratula benghalensis. Painted Snipe.

Winter. Not common. One winter a party of four to six were in residence for a month in a small patch of vegetation at the edge of a pool in open cultivation in the valley. When flushed they flew in plover fashion only a short distance to 'freeze' on fallow fields. Other years occasionally flushed out of swampy patches.

Earliest seen: November. Latest; Mid-February.

Chlidonias hybrida. Whiskered Tern.

Winter. Not common. On November 16th, a pair seen in flight over the river, one settled on the stones beside the water for a short while. The tails were not deeply forked.

Dissoura episcopus. Whitenecked Stork.

Winter. Not common. Occasional appearances solitary or in a small party about the damper cultivation of the valley.

Earliest seen: September 13th. Latest: February.

Ciconia nigra. Black Stork.

Winter. Every winter a small party of about six established headquarters about the river bed, feeding quietly near the water's edge and among the boulders. They moved up river as the water receded. Occasionally seen passing overhead in flight. The bare branches of tall trees near the river were used as perches.

Earliest seen: November 6th, usually December. Latest: February 6th.

Ardeola grayii. Pond Heron.

Mainly rains and winter. Common round any kind of water, except river side. Attendant on garden ponds. Scarce in summer.

Increase: June. Decrease: From November, gradually. January to May very scarce.

Breeding: End June to August. Colonies of nests in built-up areas, some with Night Herons.

Young: In August, the grown young had much white in the plumage, spent much time on the branches beside the nests.

Parties: Mid-September. Small parties seen in flight to and from feeding grounds in the valley. Over the sewage irrigation in the market gardens parties of fifteen to twenty birds sometimes collected.

Nycticorax nycticorax. Night Heron.

Mainly summer. Common. In flocks with day-time roosts on large trees in built-up areas, and feeding grounds in the valley.

Increase: April 10th. Decrease: end August. Usually none were seen or heard after this. But in December 1950 they could still be heard after dark, though the old colonies were deserted. Permanent residence may have been established near by.

Breeding: May to August. Usually on a certain day each pair of the flock began a shuttle service. Large twigs were collected from a group of Sal and Eucalyptus trees and carried in the bill conveyed to the colony on the usual roosting trees., where the nests grew rapidly.

Butorides javanicus. Little Green Heron.

Not common. Occasionally seen very quietly watchful along stretches of the river, using the tall grasses and shelter of boulders for cover. In September a pair took up residence in the lee of the river bank along the market gardens and could be seen there at all times of the day till the water dried up.

Nettion crecca. Common Teal.

Spring and autumn. Flights regularly seen on passage. On February 27th, a flock of sixteen, all drakes except for two or three in female plumage, rested on a sheltered pool of a swiftly running river stream. Occasional lone birds remained along the same stretch of river for short periods.

Earliest seen: August, a solitary bird. September 14th, flight heading SE. Latest seen: March 6th, flight heading NW.

Anser sp. Goose.

Spring. Regularly heard after dark, often at three or four o'clock in the morning passing loudly overhead to the NW., sometimes seen in daylight as well. The flights passed over on a few consecutive day or at intervals of a few days.

Earliest heard: February 27th. Latest: March 8th,

TIMBER BORING MOLLUSCS OF THE INDIAN COAST

I. Report on a Collection from Tondi and Adirampatnam, East Coast

BY

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(*With eight text figures*)

Abstract

Occurrence and distribution, along with the salient features, of eight species of shipworms found in two important fishing centres on the East Coast of India, are recorded. It was observed that turbidity of the water is not a deterrent factor for borers. The preference of shipworms for particular timber depends on the availability of such in the locality.

Introduction

Earlier studies by Nair (1956, 1956*a*, 1956*b*) have revealed the extent and nature of infestation by shipworms in the coastal waters of Madras on the east coast and in the Kayamkulam backwaters on the west coast. The present report extends this knowledge to two more important fishing centres on the east coast. Tondi (Lat. 9° 44′ N., Long. 79° 2′ E.) is a port on the east coast where fishing is mainly done with the help of wooden canoes made of teak, and there exist a large number of temporary cages for keeping turtles. These cages built of palmyra stems (*Borassus flabellifer*) afford excellent substrata for the molluscan larvae to settle and bore through, resulting not only in the destruction of the cages but also producing a perennial source of larvae for fresh infestation after they reach sexual maturity in a surprisingly short time. The water in this locality is very shallow and turbid, and during low tide the piles of the cages are completely exposed. Adirampatnam is also an important fishing centre where, like Tondi, fishing is done from canoes. Along the coast a large number of shipworms were collected from discarded country canoes as well as from the piles of the sluice gates controlling the flow of water into the salt pans.

In India the study of the timber boring molluscs has received very little attention in spite of the economic interest attached to such studies, probably because shipworms are the most 'inconspicuous molluscs that the sea harbours. Pilings and driftwood infested by them rarely ever proclaim their presence until they begin to disintegrate, for the tiny punctures on their outer surface are too small to reveal the enemy gnawing at their heart.' The obscure and uncertain conditions which surround the damage caused by these animals demand careful investigation of the various aspects of their biology. To formulate measures for the conservation of timber structures against the attack of marine borers certain essential facts must be gathered and properly understood. Such careful observation needs expert technical knowledge for detecting the arrival of new forms through driftwood etc., and to keep under surveillance the forms that are already present. This is possible only after a detailed enquiry into the systematics of these molluscs, and the range of distribution of the various species and their relative abundance. This is attempted here.

SYSTEMATIC ACCOUNT

Genus **Bankia** Gray 1840.

Bankia Gray, 1840, *Synop. British Mus.*, p. 76.
Bankia, Bartsch, *Bull.* 122, *U.S. Nat. Mus.*, p. 7 (1922).

The pallets consist of a series of cone-in-cone structures.

Subgenus BANKIELLA Bartsch

Bankiella Bartsch, 1921, *Proc. Biol. Soc. Washington*, **34**: 26.
Bankiella, Bartsch, *Bull. U. S. Nat. Mus.*, 100, **2** (5): 537 (1927).

Pallets consisting of a series of cone-in-cone elements covered by a thin membrane which is neither fimbriated nor denticulated at the free margin, but entire.

1. **Bankia (Bankiella) edmondsoni** Nair

Bankia (*Bankiella*) *edmondsoni* Nair, 1954, *Rec. Ind. Mus.*, **52** (2 to 4) p. 306

Occurrence: Two specimens were collected from an aerial root of *Pandanus*, cast ashore on Tondi beach on July 16, 1956.

Distribution: This form was previously recorded from Madras from a drift log (*Bambusa*), a teak plank, and a floating palm stem.

Salient features: Thin shell higher than broad, having broad anterior and anterior median lobes which form nearly 86% of

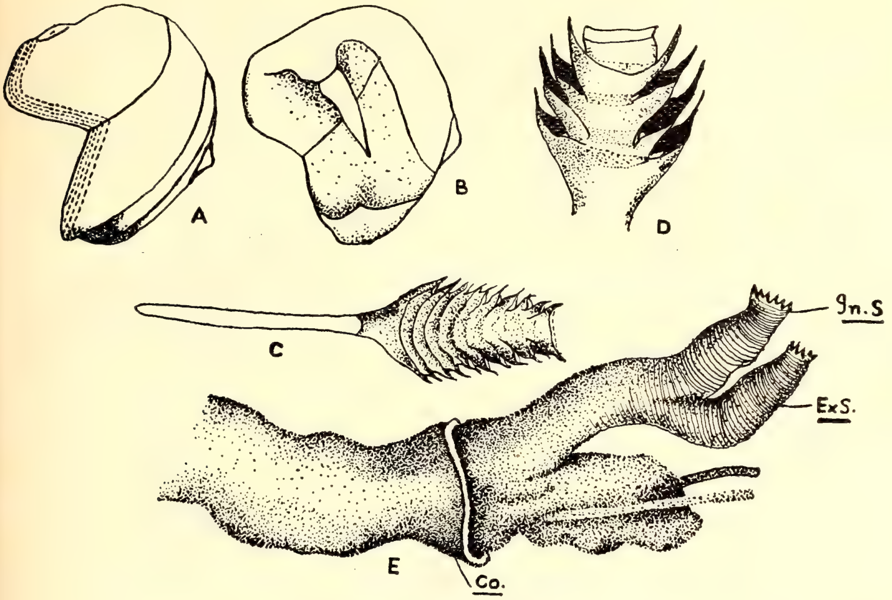

Fig. 1. *Bankia* (*Bankiella*) *edmondsoni* Nair

A. Outer view of shell. B. Inner view of shell. C. Outer view of pallet. D. Distal portion of the pallet (enlarged) to show the nature of the cones. E. Posterior part of the body showing siphons.

Co. Collar. *Ex.S.* Exhalent siphon. *In.S.* Inhalent siphon.

the total length, with an auricle which is very small like an equilateral triangle; and pallet with a stalk longer than the blade, the latter having up to 11 joints when the length is 1.7 mm.

2. **Bankia (Bankiella) indica** Nair.

Bankia (*Bankiella*) *indica* Nair, 1954, *Rec. Ind. Mus.*, **52** (2 to 4), p. 393.

Occurrence: Several specimens were recovered from the piles of the sluice gates (*Borassus flabellifer*) controlling the flow of water into the salt pans in Adirampatnam.

Distribution: This form was previously recorded from Madras as occurring on wooden buoys employed in pomfret fishing off San Thome.

Salient features: Shell breadth less than height, with a posterior median lobe greater than anterior median and middle median lobes put together, with well developed auricle; pallet with a stalk slightly shorter than the blade, the latter with up to 19 well spaced funnel-like joints when the blade length is about 8.5 mm. with yellowish brown periostracum forming a smooth entire margin drawn out into pointed processes laterally.

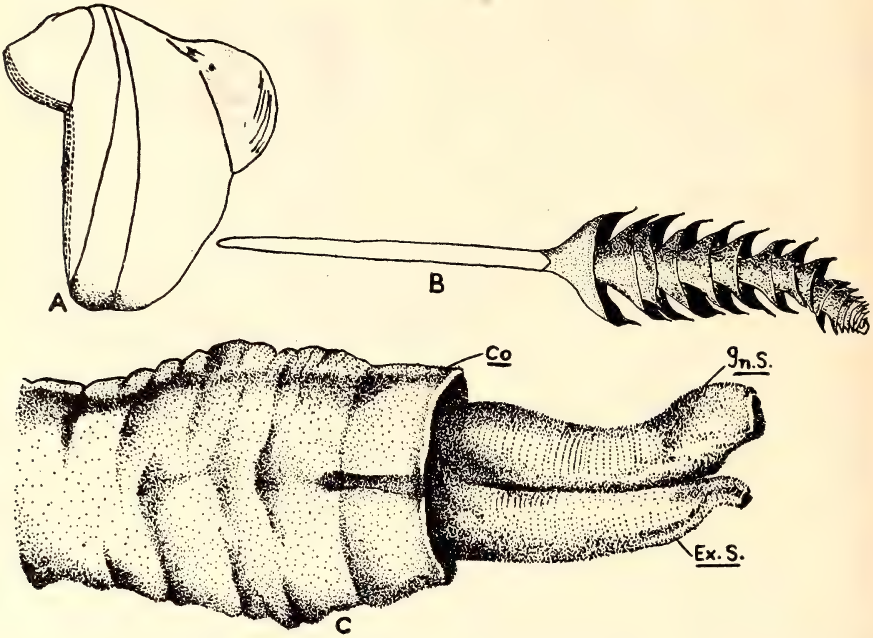

Fig. 2. *Bankia* (*Bankiella*) *indica* Nair

A. Outer view of shell. **B.** Outer view of pallet. C. Posterior part of the body showing siphons.
Co. Collar. *Ex.S.* Exhalent siphon. *In.S.* Inhalent siphon.

Siphons. Inhalent siphon wider and longer than the exhalent, with brownish spots.

Genus **Teredo** Linnaeus

Teredo Linnaeus, 1758, Syst. Nat., ed. 10, p. 651.
Teredo, Bartsch, *Bull. U.S. Nat. Mus.*, 100 2 (5): 538 (1927).

In this genus the pallets are either paddle- or spoon-shaped. They may be distally cupped or not, or they may even bear a calcareous knob at the terminal portion.

Subgenus TEREDO Linnaeus.

Teredo Linnaeus, 1758, Syst. Nat., ed. 10, p. 651.
Teredo, Bartsch, *Bull. U.S.Nat. Mus.*, 122 : 17 (1922).

Teredo has the pallets paddle-shaped, with a decidely cup-shaped depresson at the distal end. The distal portion is covered with a dark periostracum which terminates in the shape of two lateral horns.

3. **Teredo (Teredo) navalis** Linnaeus.

Teredo navalis Linnaeus, 1758, Syst. Nat., ed. 10, p. 651.

Occurrence: Several specimens of different sizes and ages have been collected from discarded country canoes made of *Tectona grandis* and the piles of sluice gates at Adirampatnam and also from the turtle cages made of *Borassus flabellifer* in Tondi.

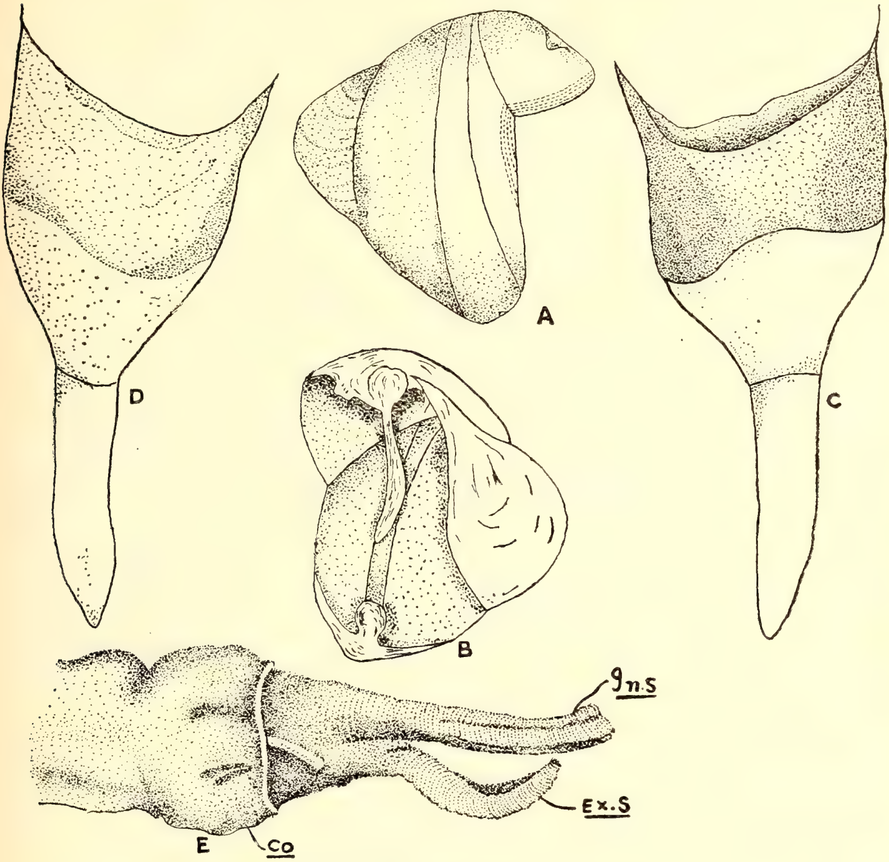

Fig. 3. *Teredo (Teredo) navalis* Linnaeus

A. Outer view of shell. B. Inner view of shell. C. Outer view of pallet. D. Inner view of pallet. E Posterior part of the body showing siphons. *Co.* Collar. *Ex. S.* Exhalent Siphon. *In. S.* Inhalent Siphon.

Distribution: This species has a very wide distribution on the Indian coast. It has been recorded from Vizagapatnam by Ganapathi and Nagabushanam and from Madras, Pulicat lake, and Vembanad backwaters by Nair.

Salient features: Pallets are spatulate with a straight cylindrical stalk which is almost of the same length as the blade. Distal part of the blade forms a dark brown periostracum which is hollowed out at the free margin and terminates in two lateral horns The basal calcareous portion of the blade is slightly convex outside and flat in the inner face.

Siphons: The inhalent is wider and longer than the exhalent. A collar is present encircling both the pallets and siphons.

4. **Teredo (Teredo) madrasensis** Nair

Teredo (*Teredo*) *madrasensis* Nair, 1954, *Rec. Ind. Mus.*, **52** (2 to 4) p. 401

Occurrence: Nine specimens were collected on July 29, 1956 from piles (*Borassus flabellifer*) at Tondi and several other specimens from a discarded country canoe made of *Tectona grandis* which was submerged in water for more than five years at Adirampatnam.

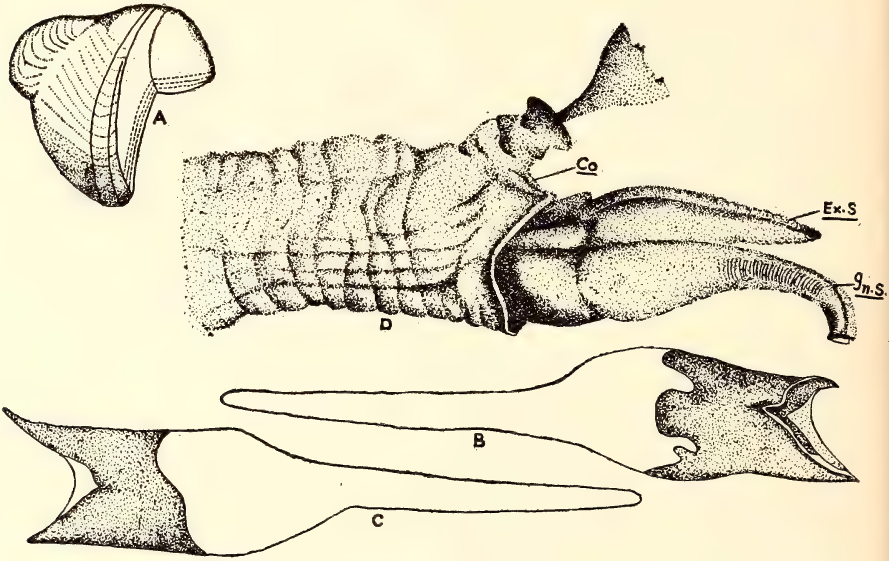

Fig. 4. *Teredo* (*Teredo*) *madrasensis* Nair

A. Outer view of shell. B. Outer view of pallet. C. Inner view of pallet. D. Posterior part of the body showing siphons.
Co. Collar. *Ex.S.* Exhalent Siphon. *In.S.* Inhalent Siphon.

Distribution: This form has been recorded by Nair from Madras from a fish float (Red cedar) and also from a plank of *Mangifera* used in a jetty construction at Kayamkulam backwaters on the west coast.

Salient features: Shell with the anterior lobe broader than high, with a well developed auricle with the anterior median and middle median bearing each up to 30 dental ridges when the shell is 4 mm. high and 4 mm. broad; pallet with a straight stalk longer than the blade, the distal two-thirds of the latter being covered either by a stalk or brown periostracum which is cupped distally and produced into two lateral projections.

Siphons: Inhalent considerably longer than the exhalent with a collar which covers only the base of the siphons and having a separate collar-like projection covering the base of the pallets as shown in the figure.

5. Teredo (Teredo) indica Nair

Teredo (*Teredo*) *indica* Nair, 1956, *Rec. Ind. Mus.*, **53** (1 and 2) in press.

Occurrence: Two specimens were obtained from a log (timber undetermined) cast ashore on Tondi beach on July 16, 1956.

Distribution: This form has been recorded from test planks of *Myristica* sp. fixed in the boat basin of Madras Harbour by Nair.

Salient features: Shell height more than shell breadth, with the anterior lobe and anterior median lobe with equal number of dental ridges, anterior median lobe forms about 47% of the median part and with a very small auricle; pallets with short cylindrical stalks, with a blade whose distal two-thirds is covered by a dark brown periostracum.

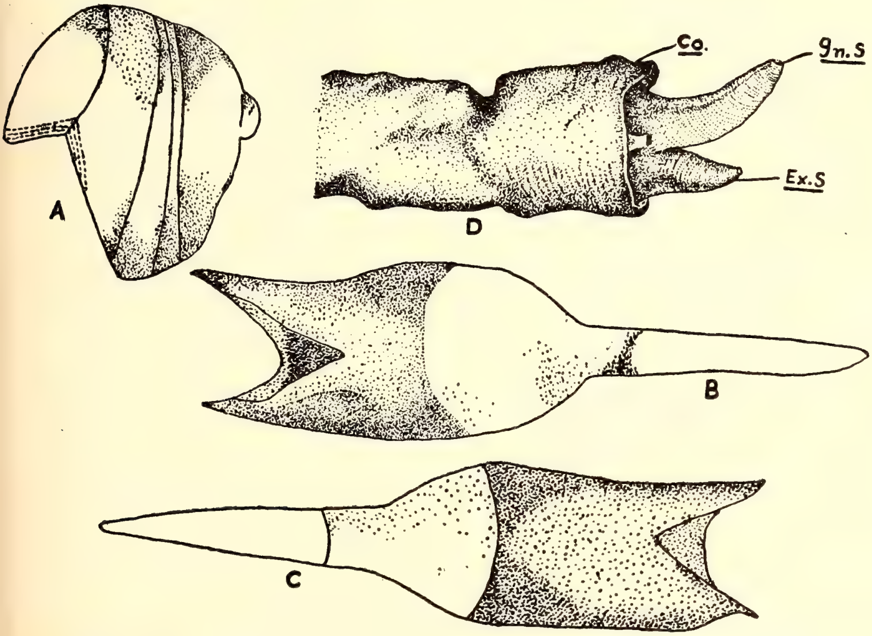

Fig. 5. *Teredo* (*Teredo*) *indica* Nair

A. Outer view of shell. B. Outer view of pallet. C. Inner view of pallet. D. Posterior part of the body showing siphons.
Co. Collar. *Ex.S.* Exhalent Siphon. *In.S.* Inhalent Siphon.

Siphons: The inhalent is wider than and about twice as long as the exhalent, with a fringed rim. Collar only slightly developed.

6. **Teredo (Teredo) parksi** Bartsch.

Teredo (Teredo) parksi Bartsch, 1921, *Proc. Biol. Soc. Washington*, **34**: 28.
Teredo (Teredo) parksi, Edmondson, *Occ. papers, B. P. Bishop Mus.*, **17** (10): 106 (1942).

Occurrence: Several shells and pallets were recovered from empty burrows in a log of wood (*Acacia planifrons*) washed ashore on Tondi beach on July 16, 1956.

Distribution: This species seems to have a fairly wide distribution. Bartsch (1921) described it from piling in Pearl Harbour. It has subsequently been reported by Miller (1924) as occurring in test blocks, Samoa; Sivickis (1928) declared it to be common in Philippine Islands. Edmondson (1942) recovered it from several stations about Hawaii, and Moll (1936) listed it from Penang Island. Nair (1956) described it as occurring in test planks of *Myristica* fixed in the boat basin of the Madras Harbour.

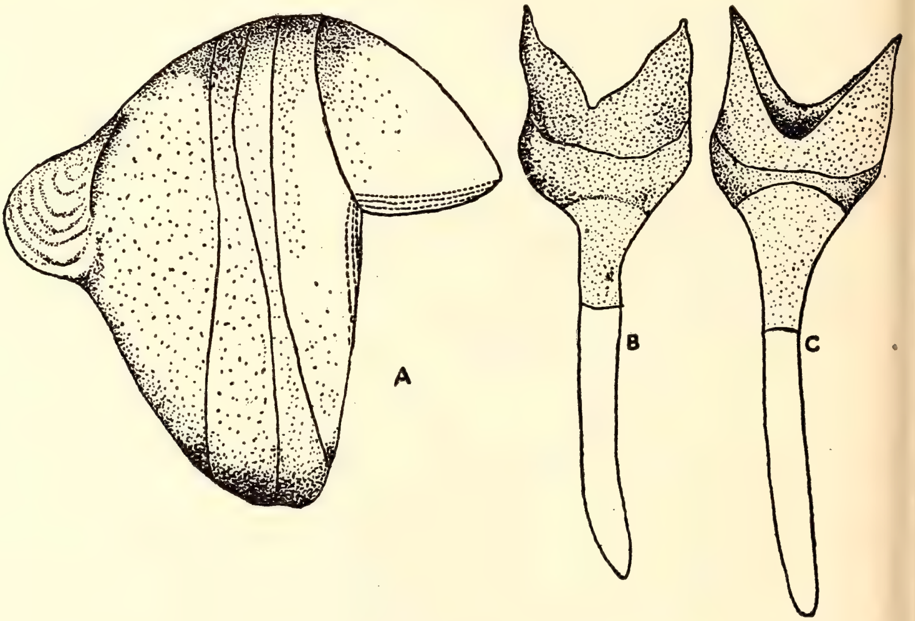

Fig. 6. *Teredo (Teredo) parksi* Bartsch

A. Outer view of shell. B. Outer view of pallet. C. Inner view of pallet.

Salient features: Shell with a broad anterior lobe and a small auricle, pallets with a long slightly curved stalk which is about twice the length of the expanded part of the blade, the distal end of the latter excavated more deeply on the convex outer surface than on the flattened inner face. The periostracum covering the distal part of the blade brownish or colourless.

Subgenus ZOPOTEREDO Bartsch

Zopoteredo Bartsch, 1923, *Proc. Biol. Soc. Washington*, **36**: 96.

The posterior part (auricle) overlaps the median part on the inside and is completely united with it, having no cavity between it and the median part at the anterior margin of the auricle. The pallet differs from those of all other known species of *Teredo* in having the calcareous portion semi-disc-shaped, i.e. very short and broad and the corneous portion partly slit and unfolded in the median line on the outside, so as to practically divide that part into a double cup, but this is not a true double cup, for it does not involve the portion.

7. **Teredo (Zopoteredo) bengalensis** Nair

Teredo (*Zopoteredo*) *bengalensis* Nair, 1955, *Rec. Ind. Mus.*, **52** (2 to 4), p. 411

Occurrence: Two shells and pallets were obtained from aerial root of *Pandanus tectorius* which was cast ashore on the Tondi beach on July 16, 1956.

Distribution: This species was previously recorded for the first time from a drift log on Madras beach by Nair.

Salient features: Shell with a well developed auricle with posterior median part 1.5 times the width of the anterior and middle median put together and with a pallet having a cylindrical translucent stalk, which uninterruptedly continues to the distal end like the shaft of a quill feather; and a translucent horn-coloured periostracum, with a sinus traversing the middle median line on the outside.

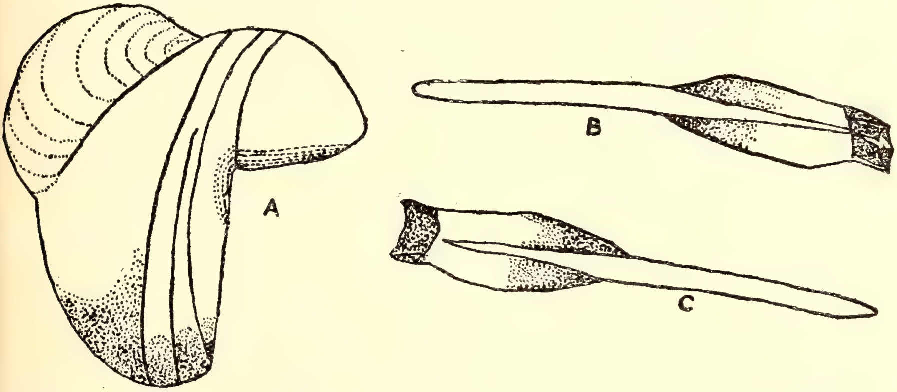

Fig. 7. *Teredo* (*Zopoteredo*) *bengalensis* Nair

A. Outer view of shell. B. Outer view of pallet. C. Inner view of pallet.

Subgenus PSILOTEREDO Bartsch.

Psiloteredo Bartsch, 1922, *Bull. U.S. Nat. Mus.*, **122**: 36.
Psiloteredo, Bartsch (1927). *Bull. U.S. Nat. Mus.* 100, 2 (5): **549**.

In this subgenus the auricle fuses with the posterior median portion on the inside in such a manner that no shelf projects. In fact, in some of the species it is difficult to note even a suture. The pallets are spoon-shaped with an outer distal portion slightly excavated.

8. **Teredo (Psiloteredo) tondiensis** sp. nov.

Occurrence: Four entire specimens and several shells and pallets were collected from the piles (*Borassus flabellifer*) used for turtle cages in the port of Tondi.

Distribution: This is the first record of the subgenus from the Indian waters.

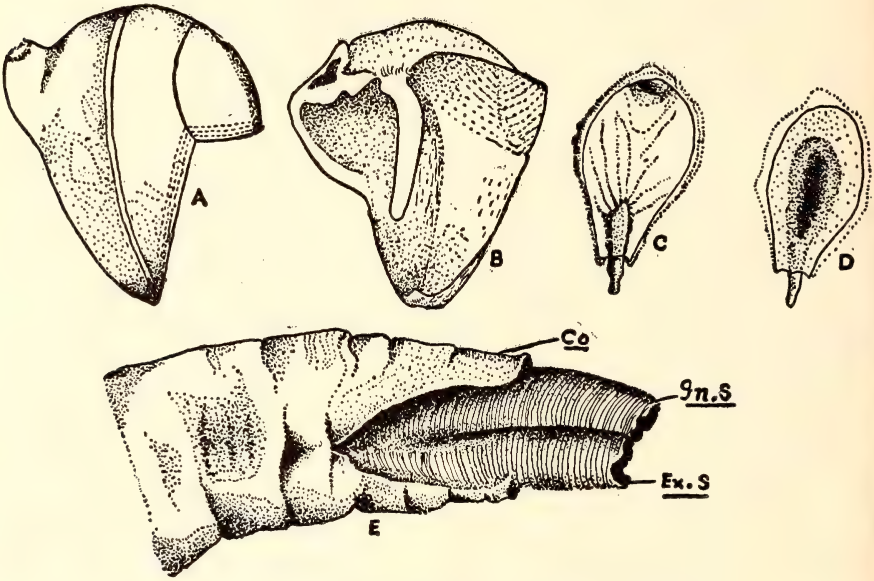

Fig. 8. *Teredo* (*Psiloteredo*) *tondiensis* Nair and Gurumani

A. Outer view of shell. B. Inner view of shell. C. Outer view of pallet. D. Inner view of pallet. E. Posterior part of the body showing siphons. *Co.* Collar. *Ex. S.* Exhalent Siphon. *In. S.* Inhalent Siphon.

Salient features: Pallets distinctly spoon-shaped with a roughly ovate blade covered by a translucent periostracum and marked by few concentric lines on the distal aspect of the outer surface, with a flexible stalk which is only slightly more than a fourth of the entire pallet length; and with a shell whose length is less than its height, with a moderately large auricle, and an anterior lobe bearing about 32 denticulated ridges when the shell length is 5.1 mm. and the shell height is 5.7 mm.

Siphons: Inhalent and exhalent of almost equal length with a slightly developed collar embracing both the siphons and the pallets.

DISCUSSION

From the foregoing survey it is clear that shipworms are remarkably active along the east coast of India. Several forms which have been recorded from Madras are recovered again from two more places suggesting wider distribution of these forms. Many authors have claimed that water pollution and turbidity are factors of some importance in the prevention of damage by marine borers (Erlanson, 1936; Ganapathi and Nagabushanam, 1955). However, it was noticed that the timber structures exposed to the turbid waters at Tondi and Adirampatnam showed considerable damage and several shipworms were collected, indicating thereby that muddy water is not a definite factor in the prevention of attack by borers. In the present study it was observed that the preference of shipworms for particular timber depends on the availability of such timbers in the locality. In the absence of such, the shipworm larvae do not die; on the other hand they would attack in unison any type of timber available, thereby bringing speedy destruction to it. This is evident from the fact that *Borassus flabellifer*, which is extensively exposed in the localities under investigation, harbours at least four species of shipworms which have been recorded previously from other types of timbers. To determine exactly whether there is any notable specificity for shipworms for a particular type of timber, more extensive field work as well as laboratory experiments are necessary.

ACKNOWLEDGEMENTS

Thanks are due to Dr. Charles Howard Edmondson, zoologist at the Bernice P. Bishop Museum, Honolulu, Hawaii for various suggestions and for the specimens of Hawaiian shipworms which he kindly sent for comparative study. Thanks are due to Dr. H. A. Rehder of the United States National Museum for a gift of publications on shipworms. The authors wish to express their gratitude to the Alagappa College Trust Board for facilities and encouragement. Grateful acknowledgements are due to Sri T. Sri Ganesan of the Botany Department for the identification of various timbers.

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GRASS FLORA OF COIMBATORE DISTRICT (SOUTH INDIA) WITH SPECIAL REFERENCE TO FODDER GRASSES

BY

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The grass floras of the districts of Chittoor (4), North and South Arcot (5), Chingleput (1), and Travancore State (6) of south India have been surveyed, and contributions made. The grass flora of Coimbatore District in south India is presented here. This is a compilation from the herbarium collections made from time to time in the Botany Section at Coimbatore, as well as collections made by the author.

The rainfall of the entire district is scanty. Coimbatore excluding the Anamalais has the lowest annual rainfall of 27 inches. At Dharapuram, Palladam, and Sulur the amount is even less and averages only 22″. Kollegal has the heaviest rainfall of 33.2″, while Mettupalayam and Pollachi come next with 33″ of precipitation. Excepting the portions of the district bordering the Palghat Gap, most parts of the districts are surrounded by the Western Ghats. Consequently very little benefit is derived from the south-west monsoon rains. About half the rainfall of the year is received during the north-east monsoon months; and even this is less than in the neighbouring districts of Salem and Tiruchirapalli. The Palghat Gap exercises considerable influence on the rainfall of the district. Portions of Pollachi and Coimbatore taluks adjoining the Gap are directly benefited by the south-west monsoon. Kollegal taluk and the Northern portions of Gobichettipalayam and Bhavani taluks above the hills form part of the Mysore plateau.

The growth and distribution of grasses depend upon the rainfall. The annuals germinate and come up after the rains; the perennials which survive the summer regenerate and put on fresh growth. Pastures of *Cenchrus ciliaris* L. and *Cenchrus setigerus* Vahl are maintained in the Kangayam tract of the district. The local breed of cattle known as Kangayam mainly feed on the above two grasses, and it is said that this fodder has something to do with the physical characteristics of the breed. Extensive areas in Kangayam are under *C. ciliaris* L. and *C. setigerus* Vahl. These grasses are raised in the paddocks of the famous cattle breeder of this tract, Pattagar of Palayakottai. In Kollegal, Alambadi, and Mysore cattle are bred and reared.

Coimbatore district is peculiar in having a distribution of several soil types. The elevation ranges from 800 to 7,000 feet above sea-level. Conditions vary from part to part, and hence the species of grasses available in the district are also many.

The grasses of the district can be classified into three groups, as follows:—

PASTURE GRASSES

1. The important pasture grasses are *Amphilophis pertusa* Stapf, *Brachiaria ramosa* Stapf, *Echinochloa colona* Link, *Setaria pallidifusca*

Stapf & Hubb., *Tragus biflorus* Schult., *Sporobolus diander* Beauv., *Cenchrus ciliaris* L., *Cenchrus setigerus* Vahl, *Cynodon dactylon* Pers., *Chloris barbata* Sw., *Dactyloctenium aegyptium* Beauv.

All the above are good fodder grasses, some of them possessing high fodder values.

FOREST OR HILL GRASSES

2. The following are a few of the most important forest and hill grasses occurring at 2,000 feet to 5,000 feet in parts of Kollegal*, Satyamangalam, Anamalais, and other hill ranges :

Sehima nervosum Stapf, *Amphilophis pertusa* Stapf, *Chrysopogon montanus* Trin., *Heteropogon contortus* Beauv., *Themeda triandra* Forsk., *Apluda aristata* L., *Eremopogon foveolatus* Stapf, *Cymbopogon flexuosus* Wats., *Cymbopogon coloratus* Stapf, *Digitaria marginata* Link, *Allotcropsis cimicina* Stapf, *Setaria intermedia* R. & S., *Brachiaria distachya* Stapf, *Panicum trypheron* Schult., *Cyrtococcum trigonum* A. Cam., *Setaria pallidifusca* Stapf. & Hubb., *Setaria verticillata* Beauv., *Aristida setacea* Retz., *Perotis indica* O. Ktz., *Eragrostis bifaria* W., *Cynodon dactylon* Pers.

GRASS WEEDS IN CULTIVATED FIELDS

3. *Amphilophis pertusa* Stapf., *Brachiaria ramosa* Stapf, *Panicum repens* L., *Paspalidium flavidum* A. Cam., *Urochloa reptans* Stapf, *Echinochloa colona* L., *Setaria pallidifusca* Stapf, *Eragrostis pilosa* Beauv., *Cynodon dactylon* Pers., *Chloris barbata* Sw., *Dactyloctenium aegyptium* Beauv.

A full list of grasses of Coimbatore district with short notes on their fodder value, distribution and economic importance, is given below :

1. **Zea mays** L.

Distribution : Throughout the district.

The common maize grown for its grain and for its dry fodder.

2. **Coix lachryma-jobi** L.

Distribution : Anamalais, Kollegal, and Siruvani.

The grains of this are rarely used as famine food and for ornamental purposes in the form of necklace.

3. **C. gigantea** Roxb.

Distribution : Top Slip, Siruvani.

4. **Chionachne semiteres** C. Fisch.

Distribution : Marudamalai, Siruvani, and Kollegal.

This grass comes up in dry localities but the leaves are too stiff and not very much relished by cattle.

5. **C. koenigii** Thw.

Distribution : Dimbam, Gaddersal.

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* Kollegal is now in Mysore State.

6. **Imperata cylindrica** Beauv., var. **koenigii** Dur.

Distribution : Kollegal

A perennial grass which becomes a weed in cultivated fields because of its hardy underground stolons. Grazed by cattle when only young and tender

7. **Saccharum spontaneum** L.

Distribution : Kollegal, Coimbatore, Dharapuram, Kaveripuram, and Siruvani.

A perennial tall grass thriving in almost all districts in moist situations. A good soil binder. Buffaloes relish the grass.

8. **Pogonatherum paniceum** Hack.

Distribution : Hasanur and Kollegal.

9. **Eulalia phaeothrix** O. Ktz.

Distribution : Anamalais, Kollegal, Marudamalai, Palamalai, and Rangaswamy Koil.

10. **Pollinidium binatum** C. E. Hubbard

Distribution : Kollegal.

11. **Ischaemum aristatum** Linn.

Distribution : Kollegal, Anamalais, Vellingiri, Anabetta, Bellagi, Poonachi, Gobichettipalayam.

12. **I. timorense** Kunth

Distribution : Hassanur.

13. **I. commutatum** Hack.

Distribution : Girimalai, Anamalai.

14. **I. rugosum** Salisb.

Distribution : Gobi, Coimbatore.

15. **Sehima nervosum** Stapf

Distribution : Hassanur, Madeswara malai, Anamalais Poonachi ghat, Girka gundy, and Coimbatore.

It is the best of all the hill grasses. It grows to two or three feet and possesses soft foliage which is relished by cattle. It is found in the forest areas of this district.

16. **Capillipedium huegelii** Stapf

Distribution : Coimbatore, Gaddersal Kottadi, Poonachi.

17. **C. filiculmis** Stapf

Distribution : ollegal, Bellagi, Anabett .

18. **Amphilophis pertusa** Stapf

Distribution : Poonachi, Hassanur, Coimbatore.

Very common throughout the State and one of the good pasture grasses. It covers extensive areas by the creeping stems, and possesses good fodder value.

18A. **A. pseudoischaemum** C. Fisch.
Distribution : Hohanapal.

19. **A. insculpta** Stapf
Distribution : Marudamalai, Dharapuram.

20. **Vetiveria zizanioides** Nash.
Distribution : Sivasamudram, Coimbatore.
An economically important grass, the roots of the grass yielding an aromatic oil. The cattle graze it when young.

21. **V. lawsoni** Blatt.
Distribution : Coimbatore, Hassanur.

22. **Sorghum nitidum** Pers.
Distribution : Rangaswami Koil, Gaddersal, Palamalai, Mudugu bole, Anaikatty, Seggani mudi.

23. **S. halepense** Pers.
Distribution : Rangaswami Koil, Gaddersal, Doddasambagi, Velliangiri, Siruvani, Coimbatore.

24. **Chrysopogon verticillatus** Trin.
Distribution : Valparai, Cinchona, Siruvani.

25. **C. orientalis** A. Camus
Distribution : Anaikatti, Palamalai, Vellingiri, Siruvani.

26. **C. zeylanicus** Thw.
Distribution : Anabetta, Bellagi, Kollegal, Marudamalai, Vellingiri.

27. **C. montanus** Trin.
Distribution : Martahalli, Kollegal, Karamadai, Palayakottai, Poonachi ghat, Gobi.

28. **C. hackelii** C. Fisch.
Distribution : Poonachi and Anamalais.

29. **Dichanthium annulatum** Stapf
Distribution : Coimbatore, Singanallur, Madeswaramalai, Kollegal, Siruvani.

30. **D. caricosum** A. Cam
Distribution : Sivasamudram, Hassanur, Talavadi, Periar, and Siruvani.

31. **D. nodosum** Willem.
Distribution : Talavadi.

32. **Heteropogon contortus** Beauv. (Spear grass).
Distribution : Throughout the district.
Perhaps the commonest grass in the forest areas of the State. Relished by cattle before flowering. The grass makes excellent hay.

33. **H. oliganthus** Blatt.

Distribution : Iyerpadi, Vellingiri.

34. **Themeda triandra** Forsk.

Distribution : Most part of the lower elevations of the districts.

35. **T. quadrivalvis** O. Ktz.

Distribution : Madeswaranmalai, Dhimbam, Kollegal.

36. **T. tremula** Hack.

Distribution : Poonachi, Anamalais.

37. **T. cymbaria** Hack.

Distribution : Hassanur, Gunkuva shola, Gaddersal, Girga gundy.

38. **Iseilema prostratum** Anderss.

Distribution : Coimbatore.

It is a rare grass but is relished well as a fodder.

39. **I. laxum** Hack.

Distribution : Singanallur, Coimbatore.

One of the ranking fodder grasses greatly relished by cattle. It is the main feed for the Ongole breed of cattle in Andhra State.

40. **Apluda aristata** L.

Distribution : Coimbatore, Marudamalai, Anamalais, Poonachi Talavadi, Anaikatti, Madeswaranmalai, Lokkanahalli, Kollegal, Gobi.

41. **Eremopogon foveolatus** Stapf

Distribution : Arepalayam, Kollegal, Coimbatore.

A good fodder grass coming up well in low elevations. It grows to a height of 1½ to 2 feet. Though the yield is poor it is one of the best fodder grasses.

42. **Andropogon pumilus** Roxb.

Distribution : Coimbatore and Gobi.

43. **Cymbopogon flexuosus** Wats. Malabar Lemon grass.

Distribution : Hassanur, Anaikatti, Kallar, Seggai mudi, Tekkan Kadu.

A cultivated grass, commonly found in Travancore and Cochin. It yields the 'Malabar Lemon Grass oil.'

44. **C. confertiflorus** Stapf

Distribution : Gaddersal.

45. **C. coloratus** Stapf

Distribution : Poonachi, Doddasambagi, Dimbham to Hassanur.

Yields an essential oil and is also used for thatching. Cattle do not relish it.

46. **C. martini** Wats.

Distribution : Kollegal and Chikkally.

The 'Geranium oil' or 'Rusa oil' is derived from this grass.

47. **C. caesius** Stapf

Distribution : Chikkally, Madeswaranmalai, Kilrupadhi, Tadagam, Satyamangalam, Sanaganur, Sayakara madai, Siruvani.

A perennial grass which possesses an aromatic oil. It is used for thatching.

48. **C. gidarba** Haines

Distribution : Cowdally, Kollegal.

This is the only species of *Cymbopogon* without any odour. A good fodder grass.

49. **Hackelochloa granularis** O. Ktz.

Distribution : Hassanur, Coimbatore.

A short grass, not very common. Cattle seem to like it.

50. **Rottboellia exaltata** L. f.

Distribution : Kottadi, Dhimbam, Anamalais, Satyamangalam, Coimbatore, Rangaswami Temple, Palamalai, Marudamalai, Muduku noele, Anaikatti.

51. **Manisuris myurus** L.

Distribution : Pollachi.

A good fodder grass with spreading habit and rooting at the nodes.

52. **Digitaria marginata** Link

Distribution : Common in the lower elevations of the district.

One of the common fodder grasses occurring throughout the district. Provides soft good fodder relished by cattle.

53. **D. marginata** Link var. **fimbriata** Stapf

Distribution : Coimbatore, Kollegal, Marudamalai, Anamalais, Hassanur, Methuganai, Shanar coupe, Palamalai, Lokkanahalli.

54. **D. griffithii** Stapf

Distribution : Poonachi, Coimbatore.

55. **D. longiflora** Pers.

Distribution : Hassanur, Anabetta, Bellagi, Kollegal, Dharapuram, Pollachi.

A short grass found mainly in forest areas.

56. **D. royleana** Pr.

Distribution : Poonachi, Anamalais.

57. **Alloteropsis cimicina** Stapf

Distribution : Hassanur, Udumalpet, Poonachi, Pollachi, Gobi, Kunjur, Coimbatore.

Found commonly in low elevations. Cattle relish it well but the yield is very low.

58. **Axonopus compressus** Beauv.

Distribution : Valparai, Chinchona.

59. **Eriochloa procera** C. E. Hubb.

Distribution: Madeswaranmalai, Gobi, Coimbatore.

60. **Brachiaria distachya** Stapf

Distribution: Madeswaranmalai, Hassanur, Marudamalai, Pollachi, Palayakottai, Dharapuram, Anaipadi, Anamalais, Coimbatore, and Satyamangalam.

A common spreading fodder grass which thrives well in moist situations. Cattle graze it readily.

61. **B. mutica** Stapf

Distribution: Coimbatore.

A very good fodder grass suited for heavy areas. Produces profuse foliage and yields well.

62. **B. eruciformis** Griseb.

Distribution: Cowdally, Sanganur.

Thrives well in black cotton soils. Cattle graze it readily, but the quantity of fodder produced is not much.

63. **B. semiundulata** Stapf

Distribution: Poonachi.

64. **B. ramosa** Stapf

Distribution: Arepalayam, Kollegal, Satyamangalam, Coimbatore, Poonachi, Pollachi, Mettur, Shanar coupe, Punganjeri, Siruvani, north Palamalai.

A grass weed the grains of which are used as an article of food.

65. **B. semiverticillata** Alst.

Distribution: Ichipalli, Marudamalai, Palamalai, Ponachi, Methuganai.

66. **Paspalum scrobiculatum** L.

Distribution: Cowdally, Kollegal, Coimbatore, Gundal river, Valparai, Bolampatti Valley, Hassanur.

The grass is cultivated for the sake of its grain which is a daily article of food in certain districts of the State such as Ramnad and Madras.

67. **P. orbiculare** Forst.

Distribution: Cowdally, Kollegal.

68. **P. conjugatum** Berg.

Distribution: Kallar, Way to Anaipadi, Anamalais.

69. **Paspalidium flavidum** A. Cam.

Distribution: Coimbatore, Anamalais, Gundal, Bellagi, Gobi, Hassanur.

One of the best pasture grasses which is an annual. Cattle relish it well.

70. **P. geminatum** Stapf

Distribution : Coimbatore, River Aliyar, Pollachi, Udumalpet, Wetlands-Central Farm, Coimbatore, Sayakara madai.

71. **Urochloa panicoides** Beauv.

Distribution : Hassanur, Coimbatore, Talamalai, Kollegal.

A spreading annual thriving in moist situations. A good pasture grass relished by cattle.

72. **U. setigera** Stapf

Distribution : Coimbatore.

73. **U. reptans** Stapf

Distribution : Coimbatore, Dharapuram, Satyamangalam.

74. **Echinochloa colona** Link

Distribution : Throughout the district.

An annual coming up well in moist situations and paddy lands. Relished by cattle. The grain is eaten by the poor.

75. **E. crus-galli** Beauv.

Distribution : Coimbatore.

A common grass thriving in moist places and rice fields. The grain is eaten by the poor.

76. **E. stagnina** Beauv.

Distribution : Palayakottai, Central Farm, Coimbatore Wetlands.

77. **Oplismenus compositus** Beauv.

Distribution : Hassanur, Karian shola, Anamalais, Rangaswami Koil, Palamalai.

78. **Panicum psilopodium** Trin.

Distribution : Coimbatore, Palayakottai, Gobi, and Pollachi.

It is an annual growing to a height of 1 to 2 feet.

79. **P. trypheron** Schult.

Distribution : Pollachi, Poonachi, Central Farm, Coimbatore, Mettur, Thotta betta, Kollegal.

A forest grass growing to a height of 2 feet. It is relished by cattle.

80. **P. paludosum** Roxb.

Distribution : Kavaripuram.

81. **P. antidotale** Retz.

Distribution : Cowdally, Coimbatore.

82. **P. maximum** Jacq.

Distribution : Throughout the district.

The common guinea grass cultivated under irrigation. Gives enormous yields and is well relished by cattle.

83. **P. repens** L.

Distribution: Common throughout the district.

Found as a weed on the bunds of paddy fields. It is much relished by cattle and is said to improve the milk yield.

84. **P. montanum** Roxb.

Distribution : Hassanur, Anaipadi.

85. **P. subeglume** Trin.

Distribution : Coimbatore, Shanar coupe, Bhavani, Palayakottai.

86. **Cyrtococcum trigonum** A. Camus

Distribution: Parapatti, Siruvani, Talavadi, Anaikatti, Hassanur, Madeswaranmalai.

A shade grass occurring in forests. A poor yielder.

87. **C. oxyphyllum** Stapf

Distribution : Karian shola, Anamalais, Cinchona, Valparai, Gaddersal, Rangaswami Koil, Palamalai.

88. **C. patens** A. Cam.

Distribution : Bellagi, Kollegal.

89. **C. radicans** Stapf

Distribution : Poonachi, Talavadi, Karadimalai.

90. **C. longipes** A. Cam.

Distribution: Kallar, R. F.

91. **Saccolepis interrupta** Stapf

Distribution : Kollegal.

Found in swampy places and grazed by cattle.

92. **S. indica** Chase.

Distribution : Poonachi.

93. **Setaria palmifolia** Stapf

Distribution: Vellingiri hills, Gaddersal, Punganjeri, Gundal River, Kollegal, Karadimalai, Rangaswami Koil, Palamalai.

Found in lower elevations.

94. **S. italica** Beauv.

The Italian millet is widely cultivated and occasionally found as an escape.

95. **S. pallidifusca** Stapf

Distribution: Hassanur, Way to Poonachi, Dharapuram, Pollachi, Girmalam, Punganjeri, Coimbatore, Dhalapbetta, North Palamalai.

A fair fodder relished by cattle. The grain is said to be eaten by the poor class of people.

96. **S. intermedia** R. and S.

Distribution: Coimbatore, Kollegal, lower Anamalais.

An annual which comes up in moist situations. Relished by cattle.

97. **S. verticillata** Beauv.

Distribution: Anaikatti, Singanallur, Punganjeri, Poonachi, Coimbatore.

An annual found rambling on bushes. Cattle graze it before flowering.

98. **Pseudoraphis aspera** Pilg.

Distribution: Coimbatore.

99. **Pennisetum typhoides** Stapf et Hubb.

Cultivated for the grains.

100. **P. hohenackeri** Hochst.

Distribution: Cowdally, Coimbatore, Talavadi, Kollegal.

101. **Cenchrus ciliaris** L.

Distribution: Throughout the districts in plains.

A common grass of the district, which is the main feed for the Kangayam breed of cattle. Highly relished by cattle. It thrives in dry areas and stands cutting well.

102. **C. setigerus** Vahl

Distribution: Throughout the district in plains.

As good as the above grass and grown along with it in the pastures at Kangayam. It thrives in dry localities and stands cutting well.

103. **Isachne kunthiana** W. et A., var. **latifolia** Hk.f.

Distribution: Anamalais.

104. **I. dispar** Trin.

Distribution: Gobi, Coimbatore.

Readily eaten by cattle and horses. A troublesome weed in rice fields.

105. **I. angladei** C. Fisch.

Distribution: Anamalais.

106. **Arundinella avenacea** Munro

Distribution: Iyerpadi and Anamalais.

107. **A. mesophylla** Nees

Distribution: Poonachi.

108. **A. setosa** Trin.

Distribution: Seggani mudi, Anaipatti.

A forest grass growing to a height of 2½ to 3 feet

109. **A. holcoides** Trin.

Distribution : Poonachi.

110. **A. pumila** Steud.

Distribution : Throughout the district.

111. **A. fuscata** Nees

Distribution : Poonachi, Anamalais, Vellingiri.
An excellent fodder thriving from 3000′–7000′.

112. **Zenkeria elegans** Trin.

Distribution : Anamalais, Marudamalai, and Seggani mudi.

113. **Arundo donax** L.

Distribution : Dharapuram, Kollegal, Singanallur, and Coimbatore.
Not good fodder though cattle sometimes eat it.

114. **Phragmites karka** Trin.

Distribution : Thonkadavur, River Alliar, and Walayar.

115. **Aristida depressa** Retz.

Distribution : Throughout the district.

116. **A. setacea** Retz.

Distribution : Throughout the district.
Rejected by cattle. It is used for making brooms.

117. **A. hystrix** L.

Distribution : Palayakottai, Pollachi, Coimbatore, Cowdally, Mettur (lake-bed), Shanar coupe.

A perennial grass not touched by cattle, because of the presence of long awns.

118. **A. mutabilis** Trin.

Distribution : Pappanaickenpalayam, Railway line, Coimbatore.

119. **A. funiculata** Trin.

Distribution : Kollegal, Satyamangalam.

120. **Garnotia scoparia** Stapf

Distribution : Poonachi.

121. **Trachys muricata** Steud.

Distribution : Palayakottai, Satyamangalam, Coimbatore.
It is often found near the seashore. Cattle graze it.

122. **Tragus biflorus** Schult.

Distribution : Shanar coupe, Hassanur, Mettur, Singanallur, Coimbatore, and Pollachi.

A prostrate grass which thrives in sandy and dry localities. Cattle do not relish it.

123. **Perotis indica** O. Ktz.

Distribution : In many parts of the district.

A slender grass growing to a height of 1 to 2 feet. Not considered good fodder.

124. **Sporobolus diander** Beauv.

Distribution : Madeswaranmalai and Coimbatore.

It comes up in shady places but it is not considered good fodder.

125. **S. wallichii** Munro

Distribution : Hassanur, Botanical Gardens, Coimbatore.

A short grass which thrives in shady situations.

126. **S. tremulus** Kunth

Distribution : Dharapuram.

A short perennial pasture grass. It thrives well in alkaline soils and makes excellent lawns. It is relished by cattle.

127. **S. spicatus** Kunth

Distribution : Coimbatore and Sivasamudram.

128. **S. piliferus** Kunth

Distribution : Poonachi.

129. **S. coromandelianus** Kunth

Distribution : Coimbatore, Agricultural College and Research Institute, Coimbatore, Palayakottai, Central Farm of Coimbatore.

Poor fodder.

130. **S. scabrifolius** Bhide

Distribution : Coimbatore.

An annual, common in black cotton soils. It is readily grazed by cattle.

131. **Leptochloa uniflora** Hochst.

Distribution : Poonachi.

132. **L. obtusiflora** Hochst.

Distribution : Singanallur.

133. **L. chinensis** Nees

Distribution : Gobi, Coimbatore, and Kollegal.

Moderately good fodder growing in moist situations.

134. **Eragrostis ciliaris** Link

Distribution : Arepalayam, Kollegal, Anaipadi, and Punganjeri.

A rare grass growing to a height of 1 ft. Cattle relish it.

135. **E. aspera** Nees

Distribution : Coimbatore, Punganjeri, Madeswaranmalai, Lokkanahalli, Kollegal, and Anaikatti.

136. **E. viscosa** Trin.

Distribution : Talavadi.

Said to be disliked by cattle.

136A. **E. plumosa** Link

Distribution : Madeswaranmalai, Kunjur, Pollachi.

137. **E. tenella** R. et S. var. **plumosa** Stapf

Distribution: Madeswaranmalai, Kunjur, Pollachi.

138. **E. diarrhena** Steud. var. **koenigii** C. Fisch.

Distribution: Coimbatore.

Readily eaten by cattle.

139. **E. unioloides** Nees

Distribution: Poonachi. Gaddersal, Cinchona Plantations, Valparai.

140. **E. gangetica** Steud.

Distribution: Between Aliar and Thorakadavoor, Doddahalla, Kollegal, Hassanur, Kallar, R.F.

Readily eaten by cattle.

141. **E. nutans** Nees

Distribution : Sivasamudram.

142. **E. cilianensis** Link

Distribution: Poonachi, Kollegal, Ramapuram, Central Farm, Coimbatore, Cowdally, Periyar, Kunjur, Anakaraimalai, Lokkanahalli.

An annual often found as weed in cultivated lands.

143. **E. poaeoides** Beauv.

Distribution : Satyamangalam, Marudamalai.

144. **E. willdenoviana** Nees

Distribution: Coimbatore, Pollachi.

145. **E. tenuifolia** Hochst.

Distribution : On the way to Poonachi, East of Madeswaranmalai, Hassanur, Rangaswami Koil, Kottadi.

Though not a good yielder is grazed by cattle. A forest grass growing undershade.

146. **E. pilosa** Beauv.

Distribution : Palayakottai, Poonachi, Hassanur, Coimbatore, and Kunjur.

Often noticed as a weed in standing crops. The grass is not considered as good fodder.

147. **E. nigra** Nees

Distribution : Kottadi, Kallar R.F.

148. **E. bifaria** W.

Distribution: Satyamangalam, Udumalpet, Palayakottai, Coimbatore, Hassanur, Thornakal thadagam, Kollegal, Perukupathi and Marudamalai.

Reported to yield fodder. It occurs in dry and poor soils in the forests.

149. **E. brachyphylla** Stapf

Distribution: Pollachi.

This grass is more or less similar to the above.

150. **Oropetium thomaeum** Trin.

Distribution: Shanar coupe, Coimbatore.

A very short grass occurring in dry localities.

151. **Tripogon jacquemontii** Stapf

Distribution: Poonachi.

152. **T. bromoides** Roth.

Distribution: Poonachi, Vellingiri, Hassanur, Arepalayam.

153. **T. pungens** C. Fisch.

Distribution: Poonachi.

154. **Enteropogon monostachyos** K. Schum.

Distribution: Madeswaranmalai, Shanar coupe, Pollachi, Satyamangalam, Rangaswami Koil, Marudamalai, Botanic Gardens, Coimbatore, Kollegal.

It thrives in dry forest regions. Comes up in plains also. A good yielder with high fodder value. Stands cutting well.

155. **Cynodon dactylon** Pers. Doob grass.

Distribution: Throughout the district.

A highly nutritious fodder especially for horses. Makes excellent lawns, but becomes a weed in arable lands where its eradication is a problem.

156. **C. dactylon** Pers. var. **intermedius** C. Fisch.

Distribution: Throughout the district.

157. **C. barberi** Rang. et Tad.

Distribution: Shanar coupe, Hassanur, Marudamalai, Chellampalayam.

A good pasture grass resembling *hariali*, differing mainly in the absence of underground stems.

158. **Chloris incompleta** Roth.

Distribution: Hassanur, Madeswaranmalai, Anaikatti.

Eaten by cattle before flowering. A forest grass growing under shade.

159. **C. barbata** Sw.

Distribution : Throughout the district.

It grows to 1½ ft. and is one of the few grasses thriving in alkaline soils. It is a good fodder grass.

160. **C. bournei** Rang. et Tad.

Distribution : Thalamalai R.F., and Coimbatore.

161. **C. montana** Roxb.

Distribution : Coimbatore.

162. **C. polystachya** Roxb.

Distribution : Rangaswami Koil, Satyamangalam, Coimbatore.

163. **Eleusine indica** Gaertn.

Distribution : Dhimbam, River Aliyar, Pollachi, Anaikatti, Coimbatore, Anamalais.

Fair as fodder.

164. **E. verticillata** Roxb.

Distribution : Poonachi.

A good fodder grass.

165. **E. lagopoides** Merr.

Distribution : Gobi.

166. **Dactyloctenium aegyptium** Beauv.

Distribution : Pollachi, Sanganur, Poonachi, north Palamalai, Anakatti, Madeswaranmalai, Punganjeri.

A creeping annual. Common in pastures and cultivated fields. Cattle seem to like it.

167. **Dinebra retroflexa** Panz.

Distribution : Coimbatore.

168. **Enneapogon elegans** Stapf

Distribution : Palayakottai, Satyamangalam, Ennamangalam, Bhavani range, Marudamalai, Kunjur.

169. **Oryza sativa** L. Rice or Paddy.

Cultivated throughout the district.

170. **O. meyeriana** Baill.

Distribution : Gundal valley, Kollegal.

171. **Leersia hexandra** Sw.

Distribution : Anamalais and Hassanur.

172. **Centotheca lappacea** Desv.

Distribution : Anamalais and Hassanur.

173. **Triticum dicoccum** Schr.
Distribution : Coimbatore (Cultivated).

174. **T. vulgare** Vill.
Distribution : Coimbatore (Cultivated).

175. **Dendrocalamus strictus** Nees
Distribution : Poonachi, Ichipalli, Gundal river, Kollegal.

176. **Bambusa arundinacea** Willd.
Distribution : Thornakallupthadam, Oosimalai, Top Slip, Hassanur, Marugalli, Karimberathadam.

177. **Oxytenanthera monadelpha** Alst.
Distribution : Anamalais.

178. **Ochlandra travancorica** Camb.
Distribution : Karian shola, Top Slip.

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ON THE MARINE FAUNA OF GULF OF KUTCH: A PRELIMINARY SURVEY[1]

BY

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(*With a map, one plate and five text figures*)

INTRODUCTION

The available knowledge of the fauna of Kathiawar coast is primarily on fishes which is mainly provided by the Fisheries Departments of Saurashtra and Bombay (1948). Hornell's paper (1916), however, gives us only a general survey of the fauna of Okhamandal. The present report is confined to Port Okha and Pirotan island (map) and was undertaken from an academic standpoint. The Kathiawar coast bordering the bay of Kutch is the nearest suitable seashore for the Rajputana students, though up to now students used to go further south to Madras and Krusadai and neighbouring islands for their marine zoological studies. It was thought worthwhile to survey and map out these regions so that in future Okha may serve as the marine zoological station for northern universities. From our survey it is found that this coastal area and the surrounding islands afford excellent facilities for zoological research.

This paper is a record of the results of the preliminary survey and is written with a view to provide an adequate idea of the ecology and systematics of the fauna of Saurashtra. With a view to obtain a more comprehensive idea of the fauna of the place several trips are planned and we hope to publish more detailed accounts of the fauna.

The present survey covers the lighthouse area and Dwarka creek of Okha, Balarpur Bay, and Hanuman Dandi of Beyt Dwarka Island (near Okha) and the north-east and west coasts of Pirotan Island (near Jamnagar). The survey was conducted from 6 to 14 June, 1956, which being a pre-monsoon month was, according to the fisheries experts, not a very suitable period for collection. In spite of this we were fortunate to find a rich fauna, both in variety and abundance. The actual period of collection was only for six days and the results from such a rapid survey will no doubt be far from complete. Our plankton collection is very meagre since only one catch was made between Jamnagar and Pirotan on the way to Pirotan Island. A report of the same will be published later.

Dr. J. P. Joshua, Professor of Zoology, Madras Christian College, with his colleagues and senior students accompanied us in this tour. We are very grateful to him for his expert guidance in the field work. Our thanks are also due to the Directors of the

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[1] Contribution No. 2 from the Zoology Department (Marine Zoology Section), Birla College, Pilani (Rajasthan).

Fisheries Departments of Bombay and Saurashtra for their co-operation and willing help in this survey, and to Dr. S. M. Mitra, Principal, Birla College, Pilani, for partly financing the project. We thank the British Museum for the identification of *Ikedella* and *Lingula*.

METHODS OF COLLECTION

The collections were made at low tide both morning and afternoon. The chisel and hammer were much in demand for breaking the stone to collect the animals which dwell inside the rocks. In some cases the spade was very useful. For the collections of animals like *Chiton* and *Cellana* (*Patella*) a simple stick was enough. In the muddy shore, most of these specimens were procured by hand, and in the sandy shore also no special collection device was necessary.

The programme of work each day was determined by the time of the low tide. The low tide allows 2 to 4 hours of collecting during the mornings, and during the evenings 2 hours. The period of the work during the mornings was the most profitable, since the low tide allowed us at least 4 hours (maximum) of continuous work. The afternoon period was much shorter as the low tide was as late as 5 p.m. which hardly left us more than 2 hours of daylight for work.

CONDITIONS OF THE AREA SURVEYED

Port Okha is situated at the tip of the Kathiawar peninsula about 630 miles north of Bombay. The bay of Kutch is bordered by a shore, which is remarkable for its variety of ecological conditions.

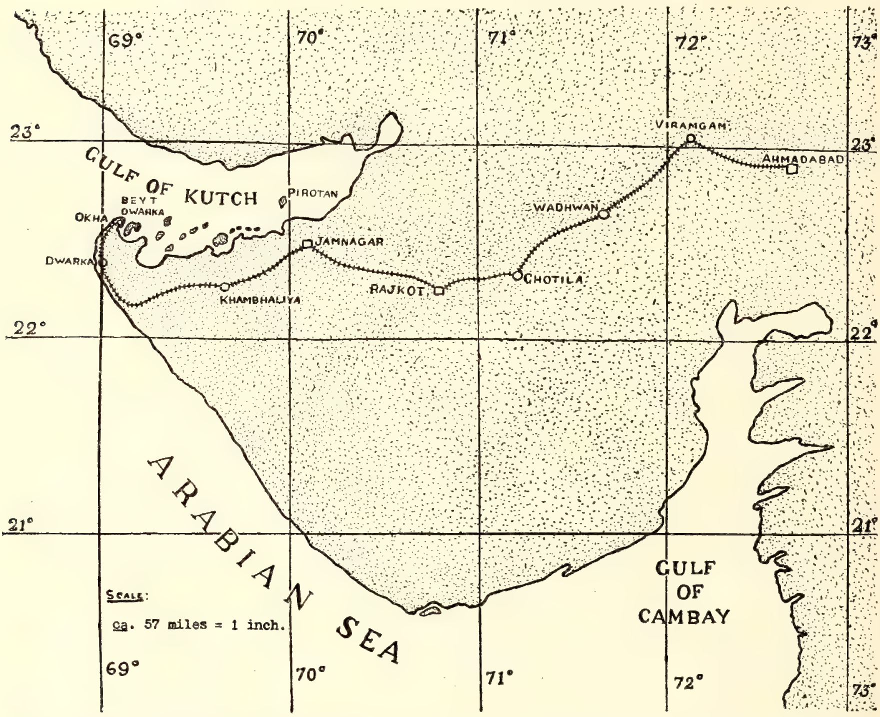
Lighthouse Area: A strip of the shore which extends from the Port area is typically rocky. During low tide the sea recedes about half a mile and the area exposed between tides is characterised by broken rocks aggregated into small heaps scattered all over. Towards the interior these rocks are covered with a layer of mud.

Dwarka Creek is in fact a continuation of the Lighthouse Area, but it presents an altogether different faunistic environment. The area is characterized by the presence of loose laterite rocks. The rocks are covered with a thick layer of mud, the thickness varying from 3″ to 10″, and in certain places it exceeds 1 foot. In these areas of soft mud are seen profuse growth of algae and diatoms. Rock pools are many, and cracks in the rocks afford good shelter for many animals. During low tide about a mile of the sea-bed is exposed.

Beyt Dwarka is an island about 4 miles east of Port Okha on the western side of the Bay. The Island is populated and its vast stretch of shore exposed between tides is an excellent field for animal collection. Collections were made at two places, viz. Balarpur Bay and Hanuman Dandi.

(*a*) Balarpur Bay: The shore exposed at low tide was muddy and the mud very deep at certain places. During low tide an extensive area about 3 to 4 miles is exposed and this was found to be very good for collection. The area is rich in fauna and many rare specimens like *Lingula* and Echiurids were collected.

(*b*) Hanuman Dandi: This coast is a mile and a half from Balarpur Bay. The exposed area is rocky and it presents certain striking peculiarities. The rocks are broken into pieces and fairly big rock-pools are found throughout the shore. At certain places the shore is sandy but as one approaches the low tide level it tends to become rocky. The area exposed during low tide extends to about 5 miles. This area is strikingly different from the Balarpur Bay in its faunistic variety.


69°
70°
71°
72°
73°
23°
22°
21°
GULF OF KUTCH
BEYT DWARKA
OKHA
DWARKA
PIROTAN
JAMNAGAR
KHAMBHALIYA
RAJKOT
CHOTILA
WADHWAN
VIRAMGAM
AHMADABAD
ARABIAN SEA
GULF OF CAMBAY
Scale:
ca. 57 miles = 1 inch.

Gulf of Kutch and the Kathiawar Peninsula : The areas surveyed are Okha, Beyt Dwarka and Pirotan

Pirotan Island: This is a small island 10 miles off Jamnagar. The island is situated in the bay of Kutch. It is rich in mangrove vegetation. During low tide a very extensive shore is exposed around the island extending to about 6 miles. The eastern side of this island is mainly rocky and covered with soft mud. Towards the inner side of this extensive area at low tide mark, an extensive coral reef is exposed. The south-west part of this island is sandy and becomes muddy as we advance to the low tide mark. At certain places the mud is very deep.

The areas surveyed present a variety of ecological conditions and accordingly the fauna was found to be most varied and representative of a number of types rarely found together. Thus the shore of the

Gulf of Kutch presents sandy beaches, rocky shores, mud flats, marshy ground, creeks, rock pools, and islands. There is no doubt that this is a very fascinating field for zoologists.

PROTOZOA

Only one collection of plankton was obtained which is awaiting study and, hence, no record of the Protozoa of these areas is possible.

PORIFERA

The area surveyed is very rich in sponges, especially the genus *Adocia*, which exhibits a variety of colours, blue, green, orange, yellow, and red. This is the most common form of sponge found in Pirotan Island and Dwarka Creek. They are generally found encrusting the rocks. Collections were also made of many sponges washed ashore.

COELENTERATA

The coelenterates are well represented in Hanuman Dandi and Pirotan Island which possess extensive areas of growing corals.

Hydrozoans and Anthozoans were found, but no Scyphomedusae[1] were collected.

HYDROZOA: *Sertularia* is found in abundance beneath the rocks and they are invariably found drifting along with seaweed.

Plumularia was collected in large quantities from Pirotan Island. Hydrozoan medusae washed ashore were collected in large numbers.

Hydroctena, a narcomedusan resembling the ctenophore in having a pair of long tentacles, was observed in the plankton.

Diphyes, a siphonophore, was also found in the plankton.

ANTHOZOA: The area surveyed is very rich in anthozoan fauna, and a variety of corals and sea anemones were collected.

Fam: Actinidae: Three genera belonging to this family were found. Specimens closely resembling *Tealiaf*, the Dahlia anemone, were found in large numbers in Hanuman Dandi. They are very beautifully coloured, the tentacles being red, with grey, green, and white lines.

Anemonea, generally known as 'snake locks', were also collected from Hanuman Dandi. Their tentacles are longer than those resembling the Dahlia anemone and are brown in colour.

Bunodactys is a small sea anemone which is brownish green in colour.

Fam : Stoicactidae: The members of this family are most spectacular. These giant sea anemones with green suckers on a large frilled disc were found along the sandy shore of Hanuman Dandi.

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[1] In our later survey during October 1956, a few scyphomedusae were also collected.

Stoicactis (Plate, fig. 1) is the common genus and is a big sea anemone, which was scooped out of the sand. The body colour is pale yellow and the disc is studded with greenish blue tubercles.

Fam: Zoanthidae: The members of the family are found in great abundance in Hanuman Dandi and Pirotan Island.

Gemmaria (Plate, fig. 2) is the most common form, very much resembling *Zoanthus*, but differing only in its small size. They grow from all sides of rocks. They are mostly green in colour and when they are expanded they present a mosaic of hexagonal figures. Red, green, and blue varieties were also collected.

Fam: Cerianthidae: *Cerianthus* was collected from Balarpur Bay. These animals live in mud in tubes secreted by them. During low tide, it is just possible to see these animals spreading out their tentacles. The collection of this is really a difficult task. It has to be quickly scooped out of the mud before the animal retracts further into the mud. The two specimens of *Cerianthus* collected were fairly large, measuring about 9″ in length. Its tube is made of a slimy secretion of the body.

Fam: Favidae: Among the living corals observed, *Favia* and *Meandria* were the most common.

Fam: Poritidae: *Porites* also occur in large numbers in Hanuman Dandi. They are grayish white in colour occurring on the rocks in the low tide belt. No living specimens were seen.

Fam: Asteridae: *Asteria* and *Sidastrea* were the two genera collected. They occur in fairly large numbers in Hanuman Dandi.

CTENOPHORA

None were found nor did the single plankton haul show any.[1]

ANNELIDA

The free living polychetes are represented by a variety of nereid worms. *Polynoe*, found in large numbers, was collected from the under surface of rocks. Large specimens of *Eurythoe* were found, living in holes and crevices of the rocks. A very interesting free living polycheata, about 2″ long, with dorsal, flat, long projections, were found. Among the tubiculous forms *Terebella*, *Amphitrite*, and *Iphione* were the most common forms.

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[1] In our recent survey during October 1956, a few ctenophores were collected.

SIPUNCULOIDEA

Dendrostoma and *Asphidosiphon* were the common sipunculids which occur in large numbers within the rocks and in the encrusted sponges.

ECHIUROIDEA

The most outstanding feature of this survey was the discovery of the echiurid worm, a bonellid, *Ikedella misakiensis* (Ikeda) (Plate, fig. 3) which so far, we believe, has not been reported from Indian waters [Gideon, Menon, Rao, and Jose, *JBNHS*, 54 (1): 201-202]. These animals were collected from Pirotan Island and are found to live inside the rocks, with only their proboscis projecting outside. This worm differs from all the known species, and work on its ecology, anatomy, and taxonomy is in progress.

BRACHIOPODA

Lingula anatima (Lamarck) (text fig. 1) species were collected in large numbers from Balarpur Bay. They are attached deep in the clayey soil by their peduncles. The peduncle is about 6″ in length in a full grown specimen and the shell is green in colour. The pedicel is attached to the lower end of the vertical burrow and the shell is normally just exposed above the top end of the burrow. When alarmed the pedicel is contracted and the shell jerked back into the burrow. The setae attached to the anterior end of the mantle lining both valves of the shell form three tubes, two lateral for ingoing ciliary currents and one central for the outgoing current removing waste matter.

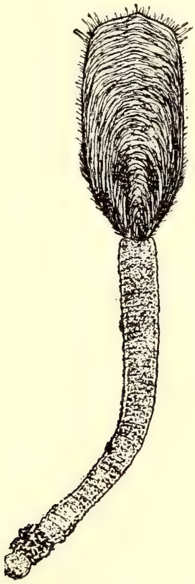


Fig. 1. *Lingula anatima* from Balarpur Bay (Beyt Dwarka). × $\frac{2}{3}$

ARTHROPODA

Among the marine arthropods, the CRUSTACEA are the most important and abundant. The Okha coast and island shores were very rich in the crustacean fauna. Hanuman Dandi seemed to prove a good abode for *Uca* (calling crabs, *Gelasimus*). At the Lighthouse beach (we call it *Chiton* shore or beach) crabs of different types were found. Pirotan Island also was very rich in crabs and other crustaceans.

COPEPODA: The copepoda found in large numbers await taxonomic study.

CIRRIPEDIA: The most common species of this group was *Balanus amphitrite* (Darwin), found in large numbers on logs of wood. (Plate, fig. 4.)

B. tintinabulum (Darwin), a larger species, was also collected from Pirotan Island. Among the parasitic cirripedes *Sacculina* was not found in the crabs collected.

ISOPODA: *Ligia* sp. was the most common example observed in very large numbers along the high tide level especially during evenings when they come out for feeding. During the daytime they hide among the logs of wood or seaweed washed ashore.

STOMATOPODA: *Squilla* was collected from Pirotan Island. *Gonodactylus* was also fairly common. Another interesting form *Periclimnus* sp. (probably *P. brevecarpalis*) was found in association (commensal) with the giant sea-anemone, *Stoicactis*.

DECAPODA: MACRURA: *Penaeus*, though not collected by us, were found in fishermen's collections. *Lucifer* was found in large numbers in the plankton collection.

Alphaeus which produces a characteristic sound by means of its appendages and *Hippolysmata* another macruran were common forms occurring in large numbers in rock pools.

Panulirus: Skeletons of this animal were found washed ashore along the Lighthouse area.

ANOMURA: Hermit crabs of the family Paguridae were collected from a variety of shells. The most common shells inhabited were *Thais* and *Telescopium*. *Diogenes* was the common genus found in the shells of *Thais*.

BRACHYURA: Calapidae: *Matuta* is the common crab which frequents the sea during low tide. They live buried in the sand. The carapace is rounded with a single stout triangular spine on each side.

Ocypodidae: The members of this family are found in large numbers especially at Balarpur Bay. The most common genus is *Uca* (*Gelasimus*) which is generally known as the 'Dhobi crab' or calling crab. The males are characterised by the possession of a very large brilliantly orange or red coloured chela. They have got the peculiar habit of waving this chela.

Portunidae: *Neptunus* is the most common genus. It is recognised by the antero-lateral margins of the carapace bearing 9 teeth and a long characteristic spine projecting sideways. They are found in large numbers in the south-west part of the Pirotan Island.

Inachidae: *Hyas* is the common spider crab found under the rocks. They have a triangular carapace and slender legs which give them the appearance of a spider.

Xanthidae: *Pilumnus* popularly known as furry crabs, in which the entire body is covered by dense profuse fur-like outgrowths in the dorsal side which helps to camouflage the crab among seaweeds and sponges, are common. These crabs were collected mainly from the eastern shore of Pirotan Island.

MOLLUSCA

The Kathiawar coast is very rich in molluscan fauna. All the important classes of the phylum are represented.

SCAPHOPODA: *Dentalium* is the common genus and its shells are found in large numbers in Balarpur Bay. The shell is tubular resembling very much in shape the tusk of an elephant. The shell is ribbed and tapering from aperture to apex. *Dentalium octangulatum* (Donovan) is the common species. It is typically 8 ribbed but certain shells collected from the same spot possess 9 ribs [Crichton (Gravely's account—*Bull. Madras Govt. Mus. Nat. Hist. Sect.* Vol. V. No. 1, pp. 25, 1941) has collected from Krusadai Island having 6 ribs which may also belong to the same species)]. If this is so then the ribs of *D. octangulatum* may vary from 6 to 9.

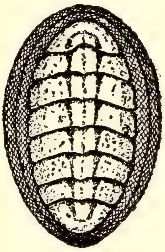


Fig. 2. Chiton—from Lighthouse Area. × $\frac{2}{3}$

AMPHINEURA: *Chitons* (text fig. 2) are found in abundance in the Lighthouse Area of Okha. It would not be an exaggeration if we name it Chiton Bay or Chiton Shore. Chitons are attached to rocks which remain partly submerged during high tide. The specimens collected do not conform to the descriptions of *Acanthochiton* or *Plaxipora* (Gravely, *Bull. Madras Govt. Mus. Nat. Hist. Sect.* Vol. V, No. 1, 1941). The largest specimen collected in Okha is 3″ in length.

GASTROPODA: Fam: Fissurellidae: Both empty shells and living animals were collected from Pirotan Island, and from Dwarka Creek (Okha) and Balarpur Bay (Beyt Dwarka) only empty shells were collected. The shells are conical with a perforation at the apex. Well pronounced radial ridges separated by concentric ridges are a characteristic feature of the shell. *Diadord* is the most common genus of the family. The shells are generally known as 'key-hole' limptes.

Fam: Patellidae: These are the true limpets. The shell is conical and resembles the Fissurellidae, but it can be easily distinguished by the absence of the conspicuous apical aperture. These limpets are common on the rocks of the Lighthouse Area ('Chiton Shore') of Okha. The specimens collected are variable in shape and coloration and 2 distinct types are recognised, one closely resembling *Patella radiata* (Born-Gravely); and the other where the shell is smooth, the profile flatter and the colour greenish brown.

Fam: Trochidae: These are the common 'top-shells'. The trochidae are well represented in Hanuman Dandi, Balarpur Bay, and Pirotan Island. The shell is conical. All the specimens were empty shells collected from the low tide level. The most common genera are *Euchelus*, *Clanculus*, and *Umbonium*.

Euchelus: The common species of *Euchelus* are *E. asper* (Gmelin) *E. indicus* (A. Ad.). The shell of the former is moderately large, gibbose and spirally ridged. The colour is brown or grey. The latter resembles the former but the spiral grooves are deeper.

Clanculus: The shell resembles *Trochus* and the species we record here is *C. depictus* (A. Ad.). It has got tuberculate spiral ridges. These specimens are scarce and only one was collected.

Umbonium: These are generally known as 'Button shells' and are found in abundance. *U. vestiarum* (Linn.) is the common species in Balarpur Bay. The shells are small and delicate, they are highly polished and exhibit different colour patterns. The colour range is red, violet, grey, white, black, with varying shades.

Fam: Turbinidae: The shells belonging to this family are known as 'turban shells'. The shell is solid with rounded whorls. The aperture is circular and has a stony operculum commonly referred to as 'Ravana's eye' or 'Ambliamma'. *Turbo bruneus* (Roding) is the most common species. They live attached to rocks and boulders between the tide levels. *Astrea stellata* (Gmelin) is another member of this family with a conical shell as in *Clanculus*, but possesses stud-like projections near the sutures. A large number of empty shells were collected from Balarpur Bay and Pirotan Island.

Fam: Neritidae: This family is well represented in Pirotan Island and Hanuman Dandi. The shells are thick and are characterized by a large whorl, a depressed spire, and a semicircular aperture. Two species of *Nerita*, *N. oryzarum* (Recluz) and *N. albicilla* (Linn.) were found. *Neritina ? crepidularia* (Lam.), a purplish black shell with transpiral white patches, was collected which closely resembles *Neritina*.

Fam: **Turritillidae**: The shells are very long and slender with numerous whorls and horny operculum. They are otherwise known as 'screw shells'. *Turitella cerea* (Reeve) is the most common species collected from Balarpur Bay.

Fam: **Littorinidae**: *Littorina* species were common in Pirotan Island.

Fam: **Architectonidae**: The shells are popularly known as 'staircase shells'. *Architectonica laevigata* (Lam.) (*Solarium*) was collected from the eastern shore of Pirotan Island and Hanuman Dandi.

Fam: **Vermetidae**: These are tubiculous sedentary gastropods and were found in large numbers in Dwarka Creek (Okha) and Hanuman Dandi (Beyt Dwarka). The shell is irregularly coiled. *Vermetus* is the common genus. The species of the genus have not so far been identified in India.

Fam: **Potamididae**: These are popularly known as 'telescope shells'. *Potamides* is the common genus having a small elongated shell and found in large numbers in Balarpur Bay. *Telescopium telescopium* (Linn.) is a very big shell, with smooth transpiral ribs (text fig. 3). The shell is seen always to be inhabited by hermit crabs. Many shells with the hermit crabs and empty shells were collected.

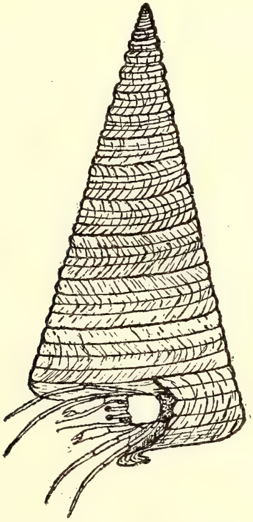


Fig. 3. *Telescopium telescopium* entertaining a hermit crab—from Pirotan Island. × $\frac{2}{3}$

Fam: **Cerithiidae**: Small empty shells probably belonging to the genus *Cerithium* were found in quite large numbers.

Fam: Cypraeidae: The shells of this family are known as 'Cowries'. *Cypraea* is the common genus. The shells are highly polished and possess the most elegant and beautiful patterns. An operculum is absent and the spire is concealed in the adult forms. Collections were made mainly from Pirotan Island and Balarpur Bay in mud-covered rocky areas. *Cypraea arabica* (Linn.) are medium sized, grey coloured shells with brown markings. *C. ocellata* (Linn.) is readily recognised by the characteristic white and black dots. This species is very common in Kathiawar though it is reported very rare on the Bombay coast. A detailed taxonomic study may reveal a large number of species.

Fam: Burcidae: The shells are characterised by the presence of continuous varices. 4 spiral lines are found between the whorls. The aperture is oval. *Bursa tuberculata* (Brod.) is the common species collected from Pirotan Island.

Fam: Pyrulidae: Empty shells were collected with two white oblique lines running from the outer lip to the groove of the columella. They are fragile shells generally found around the low tide belt. *Pyrula fiscus* (Linn.) (=*Ficula laevigata*, Ficidae—Gravely), is the common species.

Fam: Muricidae: This family is represented by a variety of shells. Some are very thick and vary greatly in coloration, shape, and structure. They were collected from mud-covered low tide belt areas of Pirotan Island. Of the many genera collected only two are identified, *Murex* and ***Thais***.

Murex tribulus (Linn.) possesses an ash coloured (living) shell with a very long narrow anterior canal. Rows of long sharp spines arise from the varices. They are popularly called 'venus comb' shells. Other species collected are awaiting identification.

Thais rugosa [Born=*Sacellun* Gmelin (Gravely)] syn. *T. sacellum* (Lam.), *T. rudolphi* (Lam.), and *T. carinifera* (Lam.) are some of the species which occur in abundance.

Thais rugosa—a larger shell, which possesses well developed processes in the first spiral ridge, less in the second, and gradually diminishing in the remaining spiral ridges.

Thais rudolphi possesses a fairly large shell, with a conical apex, and blackish brown in colour with white thickenings spirally arranged. Every fourth spiral ridge is very prominent and is slightly carinated.

T. carinifera is a very common form with a thick, strongly carinated white shell and a small columella.

Fam: Pyrenidae: These are fusiform shells with narrow aperture. They were collected from the sandy shores during low tides. *Pyrene* is the only genus identified so far.

Fam: Nassaridae: Only one genus *Nassarius* was found. This is a beautiful shell with rounded whorls and transpiral ridges. The specimen resembles *N. olivacea* (Burg.).

Fam: Xancidae: *Xancus pyrum* (Linn.), sacred chank, is the only species in our collection and they were not very uncommon.

Fam: Olividae: They are beautiful, polished shells, found generally in sand. They have a short spire and in some species the spire is depressed, fusiform in shape with aperture narrow and long. Two species were found, *O. nebulosa* (Lam.) and *O. lepida* (Duclos). The former is larger and has a pointed spire. Colour white with brownish markings. The latter is small in size with different colour patterns.

Fam: Bullidae: The shells show an inflated body whorl and a depressed spire. Only one empty shell was found and this was about 2½ inches in length with brown patches, and a wide aperture. The specimen was identified as *Bulla ampula* (Linn.).

Fam: Doridae: Only one genus *Chromodoris* was found during this rapid survey at Pirotan Island at the low tide belt. The description of the species almost tallies with that of *universitata* described by Prat (The Manual of Common Invertebrate Animals, pp. 581, 1935). The body is light blue in colour with blue and golden yellow spots (when alive). They are generally found within the crevices of the rocks, gliding slowly on the substratum. They are very small in size.

Fam: Atyidae: The shell resembles *Bulla* but is very small. A large number of specimens were found in Pirotan Island.

Haminoea galba (Pease) is a very common species. It possesses a small shell from which the animal projects. The interesting feature about its shell is that it is very transparent and fragile. They were washed ashore in large numbers. About a 100 live specimens were collected. They are generally found creeping on the mud-covered rocks at the low tide belt.

Fam: Oncididae: *Oncidium* is the common genus represented in our collection. The specimens from Balarpur Bay were exceptionally large, while the ones from Pirotan Island were uniformly small. It is quite probable that more than one species of this family is present in our collection; the specimens are being identified.

PELECYPODA: Fam: Arcidae: *Arca* was the only genus seen. They are burrowing forms; generally found in muddy shore of Balarpur Bay and Pirotan island. Two species were collected. The shells of the live animals were always covered with dark hairy periostracum. The species in our collections differs from the ones described by Gravely (*Madras Bull.*) and by Karandikar (*Bom. Uni. Jour.*, 1949).

Fam: Mytilidae: This family is represented by the genus *Lithodomus*. They are commonly known as 'date shells'. They are tapered behind, and are found to lie inside coral rocks. The common form is *Lithodomus lithophaga* (L.).

Fam: Pinnidae: *Pinna* was found in large numbers in Pirotan Island. They are generally distinguished by the large thin shell resembling the pinna (external ear) of a mammal. They are attached to the substratum by a byssus. *Pinna nigra* (Dil.) is the common species. It is reported as a rare genus on the Bombay coast.

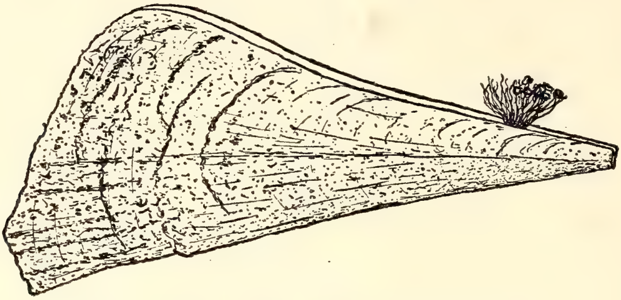


Fig. 4. *Pinna nigra* from Pirotan Island. × ⅓

Fam: Pectinidae: Only one valve of a specimen of this family was collected. It has a strong radial ridge with unequal ears of the umbo. The specimen was identified as *Chlamis singaporina* Sow. (*Pecten singaporina* Mel. & An.).

Fam: Anomidae: This family includes the common window pane oysters, e.g. *Placenta placenta* (Linn.). The shell is very thin and circular, pearly white in colour (text fig. 5) collected from Balarpur Bay, Hanuman Dandi. The washed off shells are transparent.

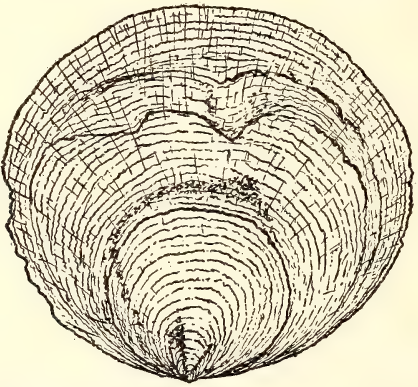


Fig. 5. *Placenta placenta*—from Balarpur Bay (Beyt Dwarka). × ⅔

Fam: Pteridae: *Pteria vulgaris* (Schumacher), the pearl oyster is the most common species of Pirotan Island. A considerable amount of work has been done on it by the Fisheries Department of Saurashtra Government. According to them (personal communication) it takes 4 years for these oysters to become adults, and the actual age is determined by measuring the length of the hinge.

Fam: Cardiidae: The typical species is *Cardium asiaticum* (Brug.). The shell is radially ridged. The ribs are strong, regular, and crested near the ventral margin. The crested variety is generally regarded as a different species from *C. asiaticum* and is known as *C. coronatum* (Spengler). No living specimen was collected.

Fam: Veneridae: This family is well represented. They are all littoral in habit and collected from Pirotan and Balarpur Bay during low tides. The following genera were observed: *Gafrarium, Sunneta, Dosinia*, and *Paphia*. The species of *Gafrarium* were not identified.

Among the *Sunneta*, *S. donacina* (Gml.) could be identified. This is a small shell with concentric striations, and decorated with orange purple lines. The genus *Paphia* is represented by three species. *P. malabarica* (Dil.) is a large shell with well developed concentric striations and slightly greyish in colour. *P. undulata* (Born) is highly polished shell with concentric growth lines. It has brownish markings which give a characteristic colour pattern to the shell. The other species is *P. textile* (Gmelin).

Fam: Mactridae. Genus *Mactra* is a triangular oval shell slightly longer than high. Only one species, *M. cornea* Desh., with concentrically grooved shell was recorded from Pirotan.

Fam: Donacidae: One species of *Donax*, *D. scrotum* Linn., is recorded from Pirotan Island. It can be easily identified by a well defined keel which starts from the umbo and tapers towards the hind end on the inside of the shell. The region round the umbo is violet coloured. Externally concentric striations and radial ridges are present.

Fam: Tellinidae: These are popularly known as 'paper shells'. Two genera are represented in our collection. They are *Tellina* and *Angulus*. In *Tellina* the umbo is anterior, and the specimen collected resembles *T. timorensis* Lam. The shell is twice as long as high and white in colour.

Angulus sinuata Speng. is the common species of the genus. The shell is fairly thick with concentric striations and the interior of the shell is pink in colour.

Fam: Solenidae: The valves gape at both ends and are truncated. The umbo is elongated and anterior in position. The genus was *Solen* and the two species were *S. truncatus* Wood and *S. lamarckii* Desh. The former species was dug out from the muddy region of Balarpur Bay. It is about 6 inches long while *S. lamarckii* is 1 inch long. Another shell of *lamarckii* measured 2½ inches in length.

Fam: Laternulidae: The shells of *Laternula* are small, thin, and very fragile. They are ivory white in colour, with ridges at the umbo. Cardinal marginal teeth are absent. Only shells of this genus were found on Pirotan Island. The shells gape widely and are iridescent inside. The species is evidently *L. labiata* Reeve.

CEPHALOPODA: Of the cephalopods only *Octopus* were collected. Hanuman Dandi and Pirotan Island were exceptionally rich in *Octopus*. They live on the underside of the small rocks and could not be recognised when still as their colour pattern completely harmonised with the environment. Among the decapods only the shells of *Sepia* were found washed ashore.

ECHINODERMATA

CRINOIDEA: Commonly known as 'sea lilies'. Two or three different varieties were noticed. One is purplish brown with ten plume-like arms resembling *Troiometra.* These specimens were found in rock pools at Hanuman Dandi. Some of the arms are branched giving a deceptive appearance of many arms.

ASTEROIDEA: The following genera were observed: *Palmipis, Astropecten,* and *Asteria.* They were all collected from Pirotan Island from the rocky region during low tide.

Palmipis species are not yet identified. All the specimens collected were from rock pools and underside of rocks during low tide.

Asteria. These were collected from shallow waters and found to possess stout rays and to some extent they are flattened. On the aboral side of each arm are prominent median longitudinal spines. Colour is of the shade of orange. *Astropecten* can easily be recognised by their five slender arms bordered by a row of large marginal plates. The tube feet are pointed. There is no anus. They were collected in considerable numbers from the low tide region of Pirotan.

All the specimens are not yet identified and a more detailed study may reveal quite a number of species.

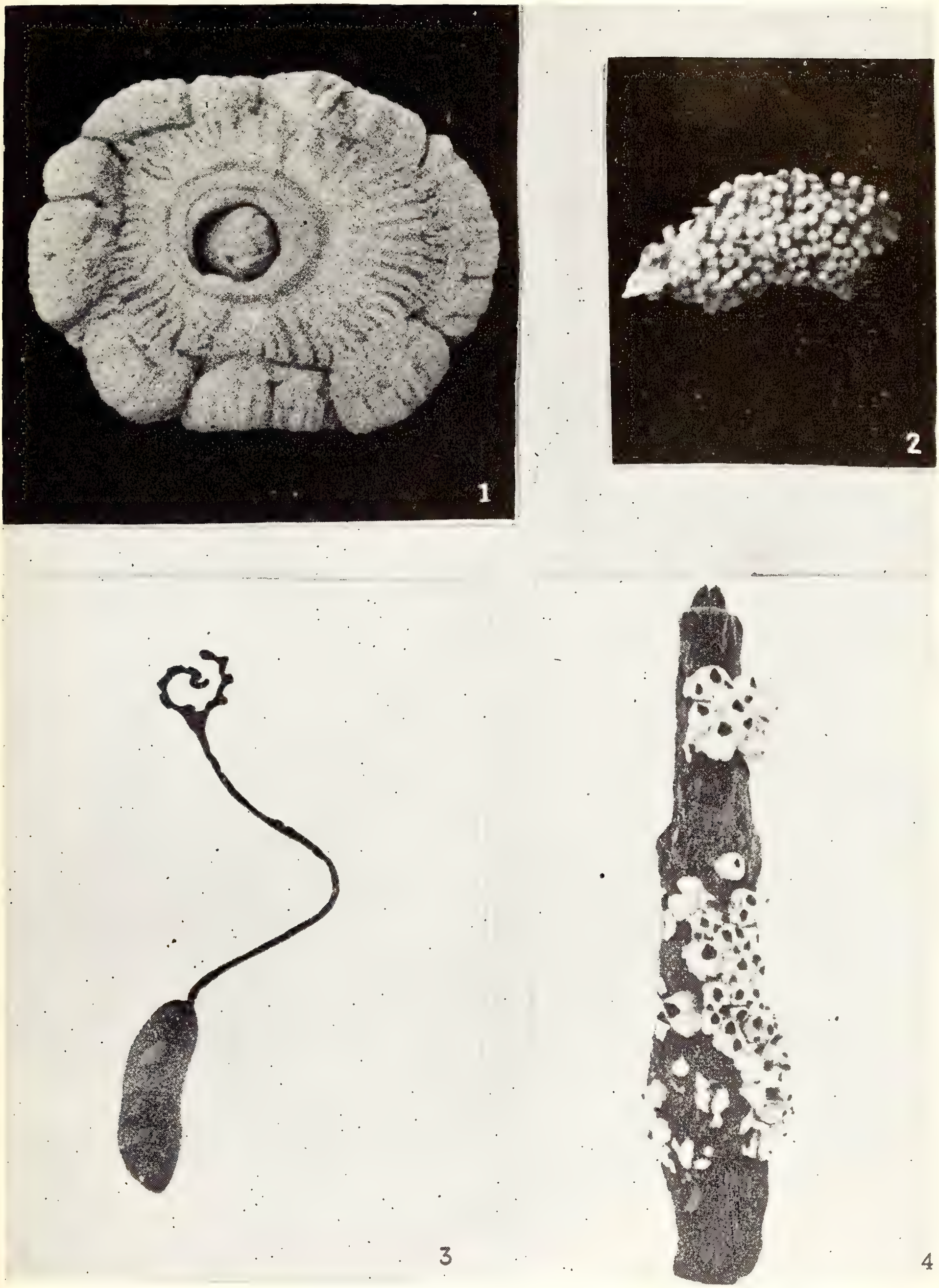
ECHINOIDEA: We have collected only one specimen belonging to the family Temnopleuridae. *Temnopleura* is the genus. It is a small form with slender spines. The spines are brown-banded. It was collected from the crevices of the rock at Pirotan.

Fam: Clypeasteridae: *Clypeaster* was another genus collected. They are easily recognised by their depressed test. The madreporite plate is in the centre of the aboral surface. The five petaloid ambulacral area radiates from this. No living specimen was collected. The corona was picked up from the low tide area of Pirotan.

HOLOTHUROIDEA: Holothuroidea is well represented at Pirotan. A variety of specimens belonging to different genera were collected from the crevices of the rocks. All of them were small in size. The only one identified is *Holothuria pardalis* (?) which seemed to be very common. The rest are under study.

CHAETOGNATHA

This is one of the minor groups including transparent pelagic worm-like animals popularly known as 'arrow worms'. They were found in large numbers in the plankton. *Sagitta* is the common genus.



1. *Stoicactis* sp. (giant sea-anemone) from Hanuman Dandi. 2. *Gemmaria* sp. from Pirotan Island. 3. *Ikedella misakiensis*, a bonellid, from Pirotan Island. 4. *Balanus amphitrite* on a log of wood, from Pirotan Island.

POLYZOA

Our collection of Polyzoa is represented only by *Membranipora.* This is an encrusting form with small tooth-like projections on the sides. They were found on the rocks exposed during low tide.

PRIMITIVE CHORDATES

UROCHORDA: These animals are mostly sessile growing permanently attached to rocks. They are easily recognised by the jet of water coming out of their atrial and oral aperture. Among the compound ascidians *Botryllus* was the most common. Some colonial forms probably *Clavellina* was collected in large numbers. *Ectenascidia thurstoni* (Herdman), another colonial form, was found in large numbers at Dwarka Creek and Pirotan. They are found in clusters attached to rocks. These animals are transparent and the oral and atrial region is brightly shaded with an orange tint. Among the simple ascidians *Ciona* and *Herdmania* were also fairly common.

Besides these, many other tunicates were also found which are not yet identified. These were all encrusting forms. Evidently the place is very rich in the tunicate fauna.

HIGHER CHORDATES

No special attempt has been made in studying the higher chordates. The specimens which were easily available at the shore were collected. The most common among these were the fishes. The muddy bed of Pirotan Island were seen to be rich in *Periopthalmus.* During low tide large numbers of them were found skipping along the mud. *Tetrodon* and *Calyodon* were other genera found in fairly good numbers in Pirotan Island and Hanuman Dandi. Other groups of animals were not collected.

CONCLUSION

From the foregoing account, it is clear that the Kathiawar coast and coastal islands offer a very good field for zoologists. Almost all the major groups of marine animals are represented. Outstanding amongst the collections was the finding of *Ikedella misakiensis* (Ikeda) for the first time from Indian waters (Gulf of Kutch). Special mention must also be made about the occurrence of *Lingula anatima* and a large number of other worms.

This is only a preliminary survey and the Department of Zoology of Birla College, Pilani, proposes to make a detailed survey of the area shortly.

(*Note:* All the specimens collected are deposited in the museum of Birla College).

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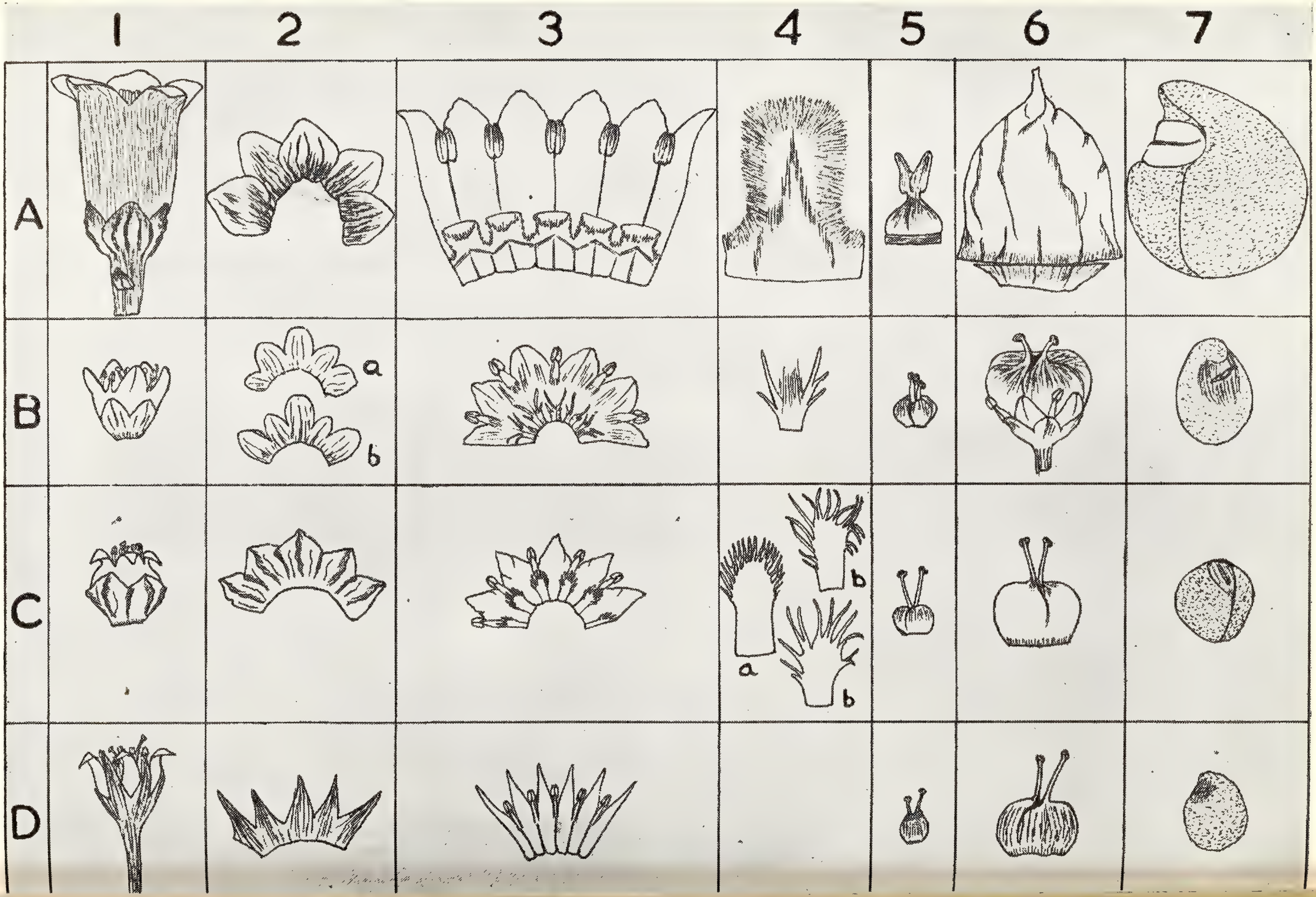
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THE GENUS *CUSCUTA* IN BOMBAY

BY

H. SANTAPAU, S.J., F.N.I.

AND

(MISS) V. PATEL, B.SC.

(*With a plate*)

In the course of studies on the Convolvulaceae of Bombay State, undertaken by the junior author under the guidance of the senior, we have noticed that little or no attention has been paid of late years to that particular group of plants belonging to the genus *Cuscuta* Linn.

The Dodders or Cuscutas are total parasites, and present a constant danger to some of our garden plants; the stems of these plants are yellowish in colour and, if left unhindered, they cover up whole hedges or garden borders with a dense network, which though interesting at first may spell the ruin of the finest garden or hedge plants. Popularly the genus *Cuscuta* is often confused with a similar parasite, *Cassytha*, which it much resembles in appearance and effects; but the latter's stems are of a deep green colour, by which alone it is possible to distinguish these two genera at sight.

The genus *Cuscuta* is usually placed in our Indian floras under the family Convolvulaceae; however, some authors, like Martius in his Flora Brasiliensis (7: 371-390), have made it into a separate family probably because of its reduced vegetative characters and parasitic habit, both of which are rare in the Convolvulaceae. But the climbing habit, the structure of the flowers, and the type of fruit certainly justify its retention among the Convolvulaceae.

The genus *Cuscuta* has been monographed by Choisy (in *Mem. Soc. Phys. Hist. Nat. Genève* 9: 261-288, tt. 1-5) in 1841; this was followed by a fuller treatment in DC. Prodr. vol. 9 in 1845; this has formed the basis of most of the subsequent monographs on the subject. Engelmann in 1859 published his 'Systematic Arrangement of the Species of the Genus Cuscuta' in the *Trans. Acad. Sci. St. Louis* (1: 453-523). The latest monograph on the subject is that of Yuncker, 'The Genus Cuscuta' in the *Mem. Torrey Bot. Club* (18: 109-331, 1932).

T. Cooke in his Flora of the Presidency of Bombay mentions three species for Bombay: *C. chinensis* Lamk., *C. hyalina* Roth and *C. reflexa* Roxb. From our observations in the field and in the herbarium, we add the following species: *C. australis* R. Br. and *C. chinensis* var. *ciliaris* Engelm., which seem to have passed unnoticed in our local floras up to the present.

The genus *Cuscuta* is widely distributed in Bombay State; *C. chinensis* proper and *C. hyalina* are found only in some parts of Saurashtra; *C. reflexa* is about the commonest species in the State, being particularly abundant in Salsette Island and on the Western

Ghats of India, where whole hedges may be infected by this troublesome parasite. *C. australis,* hitherto often confused with *C. chinensis*, has been noted from Salsette Island and from the neighbourhood of Poona; *C. chinensis* var. *ciliaris* has been recorded from Saurashtra and Poona, though again in Blatter Herbarium many specimens are classed under *C. chinensis*.

For the identification of our material we have made constant use of Yuncker's monograph, where detailed diagrams of most of the species are given; the work of van Ooststroom in Flora Malesiana I, 4 (4): 391-394, 1953, has also been of help to us in our work. Interested readers are referred to these two works as being the more reliable ones on the subject.

Cuscuta (Tourn.) Linn. Sp. Pl. 124, 1753 & Gen. Pl. 60, 1754; Choisy in *Mem. Soc. Phys. Hist. Nat. Genève* 9: 261, 1841 & in DC. Prodr. 9: 452, 1845; Benth. in Benth. & Hook. Gen. Plant. 2: 881, 1873; Peter in Engler & Prantl, Natürl. Pflazenfam. 4 (3*a*): 37, 1897; Yuncker in *Mem. Torrey Bot. Club* 18: 113, 1932; van Ooststroom in Blumea 3: 63, 1938 & in Fl. Males. I, 4 (4): 391, 1953.

Herbaceous parasites with small amounts of chlorophyll; *stems* fairly thick and coarse or thin and filiform, twining round the hosts and obtaining nourishment through haustoria. *Leaves* reduced to scales or completely absent. *Flowers* small, somewhat cymosely clustered, hypogynous, pentamerous; sepals more or less united, petals united. *Stamens* inserted on the corolla throat and alternating with its lobes; in most species there are fringed or fimbriate scale-like structures at the base of the corolla below the insertion of the filaments. *Ovary* 2-celled, ovules two in each cell; styles separate or united; stigmas capitate or elongate-triangular, fleshy. *Fruit* a capsule which may open by an interstylar opening or through an irregular line of circumscission near the base. *Seeds* 2 or 4.

A cosmopolitan genus, with many species in the warm and temperate parts of America; a few species have spread to India and Malaysia. *Cuscuta europaea* Linn. is the type species of the genus.

KEY TO THE SPECIES OF *CUSCUTA* IN BOMBAY

- Style one; stigmas conical ... *reflexa.*
- Styles two; stigmas globose-peltate:
  - Infra-staminal scales absent ... *hyalina.*
  - Infra-staminal scales present:
    - Calyx lobes not overlapping nor carinate; corolla funnel-shaped; scales 1.25 mm. long, not reaching up to the filaments, deeply bifid with 1-3 long and narrow lateral projections; capsules not enclosed by corolla nor circumscissile ... *australis.*
    - Calyx lobes overlapping, distinctly carinate; corolla globular (urceolate); scales 1.5-1.8 mm. long,

reaching up to the filaments, oblong, truncate or somewhat bifid with numerous short fimbriae; capsules enclosed by corolla, circumscissile:

Scales 1.8 mm. long, oblong, fimbriate only on the upper half ... *chinensis*.

Scales 1.5 mm. long, spathulate, truncate or rarely emarginate, fimbriate from near the base ... *chinensis* var. *ciliaris*.

THE SUBDIVISIONS OF THE GENUS *CUSCUTA* LINN.

Flowers pedicellate; corolla about twice as long as the calyx; styles two, free; stigmas globose or flattened; capsules irregular circumscissile or indehiscent ... Subgen. *Grammica*.

Capsules indehiscent ... Sect. *Cleistogrammica*.

Capsules circumscissile ... Sect. *Eugrammica*.

Flowers shortly pedicellate or sessile in close paniculate cymes; styles united, stigmas subglobose or conical; capsules regularly circumscissile ... Subgen. *Monogyna*.

Styles as long as or generally longer than the stigmas ... Sect. *Monogynella*.

Styles mostly shorter than the elongated stigmas ... Sect. *Callianche*.

Styles mostly about equal, stigmas elongated, cylindrical (rarely clavate or short conic) ... Subgen. *Cuscuta*.

SUBGEN. GRAMMICA, SECT. CLEISTOGRAMMICA ENGELM.

Emend. Yuncker loc. cit. 122; v. Ooststroom in Fl. Males. 392.

Cuscuta australis R. Br. Prodr. 1: 491, 1810; Yuncker 124, ff. 1, A-F; v. Ooststroom in Blumea 3: 66 & Fl. Males. 392, f. 1; non Hook. f. (Fig. B).

Stems slender, filiform, terete, glabrous, pale brownish yellow. *Flowers* 2-3 mm. long, in more or less compact clusters bracts minute; peduncles and pedicels very short or 0. *Calyx* greenish, membranous, funnel-shaped, glabrous, as long as the corolla tube or shorter, 1.5-1.75 mm. long; lobes as long as the tube or shorter, oblong-orbicular or broadly triangular-ovate, subequal (generally two distinctly smaller than the rest), valvate or somewhat overlapping; the whole calyx compactly surrounding the corolla. *Corolla* 2-3 mm. long, broadly funnel-shaped, greenish white; lobes as long as the tube or shorter, broadly triangular ovate or ovate orbicular, erect, not spreading. *Stamens* shorter than the corolla lobes, and inserted between them; filaments short, subulate, about as long as the ovate yellow anthers, inserted just below the sinuses of the corolla and of the same colour as the latter. *Infrastaminal scales* not reaching up to the base of the filaments, shorter than the corolla tube, deeply bifid, with 2-3 long narrow fimbriae. *Ovary* depressed-globose, obpyriform, green; styles two, thick, somewhat subulate, as long as or shorter than the ovary, slightly unequal; stigmas capitate, peltate, fleshy. *Capsule* depressed-globose or obpyriform, brown, with a wide interstylar opening, surrounded by the persistent corolla, 3-4 mm. diameter not circumscissile, i.e. indehiscent. *Seeds* 2-4, oval, brown, minutely foveolate, 1.5 mm. in diameter or 2 mm. when turgid; hilum a short diagonal line.

Flowers and Fruits: August-September.

Hosts: We have recorded this parasite on the following hosts in Bombay: *Setaria* spec., *Digitaria* spec., *Aeschynomene indica* Linn., *Solanum melongena* Linn., and on some herbaceous Compositae cultivated along edges of rice fields. Yuncker and Ooststroom have further noted it as parasite on: *Polygonum*, *Dianthera*, *Artemisia*, *Piper*, *Xanthium*, *Baccaurea*, *Croton*, *Hygrophila quadrivalvis* Nees, *Ocimum basilicum* Linn., and *Tecoma stans* Juss.

Herbarium specimens examined: Talegaon nr. Poona, *V. Patel* 1459; Tungar Hill nr. Bassein, *Patel* 1796-1805; *Santapau* 20961-20963.

Distribution: First described from Australia, but found from Turkestan and India to eastern China and Japan, and southwards to Malaya, Australia, and New Guinea. The species is not recorded from India in any of our Indian floras.

Notes: The plant is rather variable in the shape and size of the floral parts; our Bombay specimens may be about half a millimetre longer than is stated by Yuncker. The seeds are said to be used in indigenous medicine for their softening properties.

SECT. EUGRAMMICA ENGELM.

Yuncker loc. cit. 182; Ooststroom in Fl. Males. 392

Cuscuta chinensis Lamk. Encycl. Meth. 2: 229, 1786; Choisy in DC. Prodr. 9: 457, 1845; Wight, Ic. t. 1373, 1848; Clarke in Hook. f. Fl. Brit. Ind. 4: 226, 1883; Woodrow in *Journ. Bombay Nat. Hist. Soc.* 12: 172, 1898; Cooke, Fl. Pres. Bombay 2: 225, 1905; Yuncker 209, f. 80 A-G. (Fig. C).

C. sulcata Roxb. Hort. Beng. 12, 1814, nom. nud. & Fl. Ind. 1: 447, 1832; Graham, Cat. 134, 1839.

C. hyalina Wight, Ic. t. 1372, 1848, & Illustr. t. 168 b, f. 12, 1850 (non Roth).

Stems slender, filiform. *Flowers* 2.5 mm. long or slightly longer, shortly pedicellate or sessile, bracteate, in compact few-flowered clusters. *Calyx* loosely fitting round the corolla, as long as the corolla-tube, fleshy; lobes equal or slightly unequal, broad-triangular, obtuse, overlapping, strongly carinate on the outside, thickened at the base of the sinuses between the lobes. *Corolla* 2.5-3 mm. long, urceolate or globular, becoming somewhat distended in fruit; lobes narrowly triangular, acute, as long as or slightly longer than the corolla tube, spreading. *Stamens* shorter than the corolla lobes; filaments as long as or longer than the ovate anthers. *Infrastaminal scales* reaching up to the staminal filaments, oblong, shortly fimbriate on the upper half, 1.8 mm. long. *Ovary* depressed globose; styles two, unequal in length, about as long or slightly longer than the ovary, and of uniform thickness; stigmas globose-peltate. *Capsule* 2.5-3 mm. in diameter, depressed-globose, somewhat 4-lobed, completely enclosed by the persistent corolla, distinctly circumscissile. *Seeds* 1-1.5 mm. long, brown, glabrous, minutely foveolate.

Flowers and Fruits: August-October.

Hosts: We have noted the plant on *Lawsonia alba* Lamk.

Herbarium specimens examined: Rajkot, Saurashtra, *Dave* 11 October 1953.

Distribution: 'From Abyssinia, Sokotra, and Afghanistan eastward to Ceylon, Australia, and China, where it is most abundant.' (Yuncker, 210).

Notes: This plant is said to be common in various parts of India and of Bombay State in particular; but most of the specimens we have checked have turned out to be var. *ciliaris*. This species needs careful examination on an all-India basis.

Cuscuta chinensis var. **ciliaris** Engelm. in *Trans. Acad. Sci. St. Louis* 1: 480, 1859; Yuncker 210, 1932. (Fig. C, 4*b*.)

C. ciliaris Hohenack. in Boissier, Diagn. Pl. Or. Nov. 11, 3 (3): 129, 1856 (non Kotschy).

This variety is quite distinct from the typical species; its flowers are slightly larger than in the species; the staminal filaments shorter than the anthers; the infrastaminal scales are broadened upwards, truncate, rarely emarginate, 1.5 mm. long; styles somewhat thicker. The rest as in the species.

Flowers and Fruits: May-October.

Hosts: We have noted this plant on the following hosts: *Ipomoea biloba* Forsk., *Lepidagathis* spec., *Tephrosia* spec., *Indigofera cordifolia* Heyne, *Cassia tora* Linn., *Kirganelia reticulata* Baill., *Zizyphus mauritiana* Lamk., etc.

Herbarium specimens examined: Mangrol, in Saurashtra, *Santapau* 14254; Dwarka in Saurashtra, *Santapau* 16627 & 16790; Poona, *Blatter* 22715; Bombay, *D. K. Patel* (no number), October 1884; Kathiawar, *DH.* 33, June 1946.

Distribution: 'Kurdistan, Afghanistan, and Siberia' (Yuncker). The plant has been recorded from India, Wight Herb. Propr. 2408, but no locality is given by Yuncker.

Notes: We have noted this plant as common and abundant in Dwarka, just outside the railway station on numerous hosts, usually on herbs.

Cuscuta hyalina Roth, Nov. Pl. Spec. 100, 1821; Choisy 286, 1841; Clarke in Hook. f. Fl. Brit. Ind. 4: 226, 1883; Woodrow in *Journ. Bombay Nat. Hist. Soc.* 12: 172, 1898; Cooke 2: 225, 1905; Yuncker 235, f. 107 A-D (non Wight, nec Boissier). (Fig. D.)

C. arabica Wight, Ic. t. 1371, 1848 (non Fresen.).

C. boissieri Stocks in Hook. Journ. Bot. & Kew Gard. Misc. 4: 173, 1852.

Stems filiform, slender. *Flowers* 2.5-3.5 mm. long, pedicellate, bracteate, in distinct cymes; pedicels as long as the flowers and somewhat clavate; bracts distinct, triangular. *Calyx* funnel-shaped, 2.5-3 mm. long, longer than the corolla tube; lobes longer than the calyx tube, narrowly triangular, tapering. *Corolla* 3-3.5 mm. long, campanulate; lobes as long as or longer than the tube, lanceolate, tapering, slightly spreading, reflexed in fruit. *Stamens* shorter than the corolla lobes, filaments inserted at the base of the sinuses, slightly longer than the oval anthers. *Infrastaminal scales* absent. *Ovary* globose with a ring-like structure at the base of the styles; styles unequal, of uniform thickness, as long as or longer than the ovary; stigmas capitate. *Capsule* 3-4 mm. in diameter, globose or subglobose, brown, 2-celled, with a narrow interstylar aperture, surrounded by the persistent withered corolla, circumscissile. *Seeds* 1.5 mm. long, broadly oval, brown-black, minutely foveolate; hilum horizontal, oblong.

Flowers and Fruits: August-November.

Hosts: We have noted this plant on the following hosts: *Leucas urticifolia* R. Br., *Trianthema* spec., *Amarantus gracilis* Dest., *Convolvulus glomeratus* var. *volubilis* Clarke, etc.

Herbarium specimens examined: Jaisalmer, *Blatter & Hallberg* 2982; Dwarka, *Santapau* 14717, 14745-14746, 14756.

Distribution: Throughout India, Baluchistan, Kordofan to southern tropical Africa.

SUBGEN. MONOGYNA, SECT. CALLIANCHE ENGELM.

Yuncker loc. cit. 259.

Cuscuta reflexa Roxb. Pl. Coast Corom. 2: 3, t. 104, 1799, & Fl. Ind. 1: 446, 1832; Graham, Cat. 134, 1839; Choisy 273, 1841 & in DC. Prodr. 9: 454, 1845; Clarke in Hook. f. Fl. Brit. Ind. 4: 225, 1883; Nairne, Fl. Pl. W. Ind. 206, 1894; Woodrow, loc. cit. 12: 172, 1898; Cooke, 2: 224, 1905; Yuncker 259, f. 130 A-F, 1932; Ooststroom in Blumea 3: 70, 1938 & Fl. Males. 393, f. 2, 1953. (Non Decaisne.) (Fig. A.)

C. grandiflora Wall. Cat. 1318, 1829, non H.B.K.

Stems greenish yellow, glabrous, coarsely terete, verrucose with red marks. *Flowers* 6-8 mm. long, shortly pedicellate, bracteate, in cymose or paniculate clusters; pedicels 3 mm. long, fleshy, verrucose; bracts 1 mm. long, broadly triangular. *Calyx* cupulate, fleshy; lobes subequal, the outer two slightly shorter, 2-3 mm. long, broadly ovate, obtuse, fleshy, verrucose outside, with narrow membranous margins. *Corolla* white, tubular, fleshy, 6-8 mm. long; tube wide, 3-4 times as long as the lobes; lobes triangular ovate, obtuse, margins wavy. *Stamens* somewhat shorter than the corolla lobes; filaments very short, inserted at the base of the sinuses; anthers oblong; dorsifixed. *Infrastaminal scales* about one-third as long as the corolla, oblong or ovate, incurved, margins fimbriate with fine, multicellular fimbriae. *Ovary* ovate-conical, glabrous, 2 mm. in diameter; stigmas two, stout, velvety, longer than the thick style. *Capsule* globose conical, apiculate, glabrous, shrivelled when dry, 6 mm. in diameter, 5-8 mm. long, 2-celled, circumscissile. *Seeds* 1-2, each 3.5 mm. in diameter, suborbicular, rostrate, brown, glabrous, minutely foveolate; hilum a transverse scar.

Flowers: November-February; *Fruits:* April-May.

Hosts: The following have been noted by the authors: *Strobilanthes* spec., *Rosa*, *Streblus asper* Lour., *Flacourtia indica* Merr., *Clerodendrum inerme* Gaertn., *Duranta repens* Linn., *Cadaba farinosa* Forsk., *Leptadenia* spec., *Cissampelos pareira* Linn., etc. Yuncker and Ooststroom mentioned the following: *Nerium*, *Adhatoda*, *Calotropis*, *Parkinsonia*, *Zizyphus*, *Peristrophe*, *Achyranthes*, *Carissa*, *Cestrum*, *Boehmeria*, *Stachytarpheta*, *Polygonum chinense* Linn., etc.

Herbarium specimens examined: Baroda: *V. Patel* 1220-1228; *N. Irani* 532; *G. L. Shah* 1652; Ahmednagar: *A. C. K.* 1427; Victoria Gardens, Bombay: *Blatter* 14611, 14943; Versova: *Santapau* 138/35, 56-57, 59; Borivli: *V. Patel* 1304-1305; Vehar Lake, *V. Patel* 1320; Ghodbunder: *Bole* (no number); Khandala: *Blatter* 22177; *Santapau* 14057, 14058, 15490-15493; Dharwar: *Sedgwick* 3688; Ghulam: *J. Fernandes* 82.

Distribution: Throughout northern India, extending north to Afghanistan and East to Yunnan, China, and Java; rare in the south of India and Ceylon.

Notes: The type of this species is not definitely known, but seems to be of Indian origin, probably from Andhra State. It is now spread all over India, but more particularly in the northern parts. The plant is striking in that branches often turn parasitic on other branches of the same plant. It is found almost completely covering the host plant with a dense network of a light yellow colour.

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EXPLANATION OF PLATE

1. Whole flower × 4* **2** External view of calyx × 4 **3.** Inner side of corolla × 4 **4.** Infrastaminal scales × 10 **5.** Ovary × 4 **6.** Capsule × 4 **7.** Seed × 8

A. *Cuscuta reflexa* Roxb.
B. *Cuscuta australis* R. Br.
C. *Cuscuta chinensis* Lamk. (4a. *C. chinensis*; 4b. var. *ciliaris*.)
D. *Cuscuta hyalina* Roth.

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*The magnification refers to linear magnification, not the times the diagram may exceed the original.

OPERATION OF THE *DOL* NET OFF THE SAURASHTRA COAST[1]

BY

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(*With seven text figures*)

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1. INTRODUCTION

The 'Dol' net is a very important gear used on the Bombay and Saurashtra coasts mainly for 'Bombay-ducks', *Harpodon nehereus*, which are caught in millions by this means. Very few workers have described this net and its operation. Pillay (1948) gives a somewhat simplified diagram of the net and describes a few details. Hornell (1950) gives some information on the 'Dol' net as it is operated on the Saurashtra Coast. Setna (1954) in a popular article describes all the three methods employed in operating this net and also explains in detail the ingenious method employed by the fishermen of Versova and Satpati in driving the wooden spikes (*pyale*) in the muddy bottom. I am not aware of any paper in which details of the net itself and its accessories are given, or the method of operation, especially off the Saurashtra Coast, is described. It is attempted here to give a full description of the net and the ropes attached to it, and describe the precise method of shooting and hauling the net as practised in Saurashtra waters, exclusive of Kodinar.

2. FISHING GROUNDS

The recognised grounds for the Bombay-ducks off Saurashtra are situated about 6 to 12 miles south and south-east off the southern coast of Saurashtra between Nawabunder and Jafrabad, in latitudes 20° 35′

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[1] Published with the permission of the Government of Bombay.

N. to 20° 40′ N. (see map, fig. 1). Off Jafrabad, the grounds are somewhat farther than off Nawabunder. The depth of water ranges between 10 and 15 fathoms and the bottom is soft mud. There is a strong tidal current all along the coast which is very essential for the proper operation of this net.

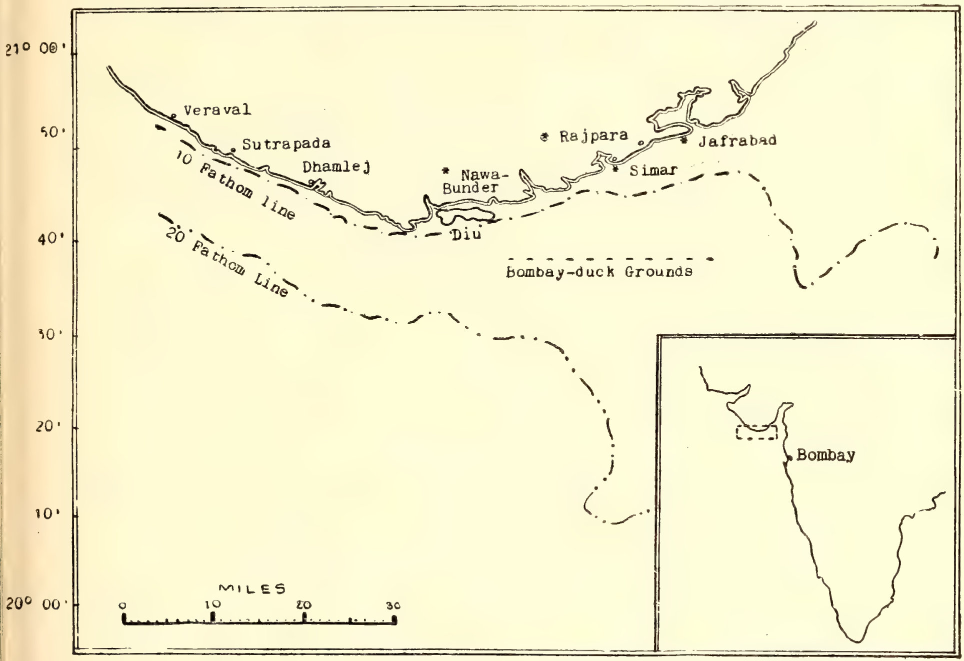
21° 00'
50'
40'
30'
20'
10'
20° 00'
Veraval
Sutrapada
Dhamlej
10 Fathom line
20 Fathom Line
* Rajpara
Jafrabad
* Nawa-Bunder
* Simar
Diu
Bombay-duck Grounds
MILES
0
10
20
30
Bombay

Fig. 1. Map of the southern coast of Saurashtra.
Bombay-duck ports are marked by asterisks.

Harpodon neherus is usually found along with *Coilia dussumierii*, *Peneus*, and *Metapeneus* species, immature *Stromateus cinereus*, *Trichiurus savala*, and a few other less important species. This appears to be a set ecological community because the same species are also found together in the trawl catches of M.F.V. 'Sagar Pravasi'. This shrimp trawler operating under the exploratory fishing scheme of this Directorate has been trawling for prawns with a shrimp trawl in depths varying between 3 to 15 fathoms in the Gulf of Kutch where there is no regular Bombay-duck fishery.

3. The Net

The 'Dol' net is made up either from cotton yarn No. 20 made into plies varying between 4 to 10, or from Hemp twisted by the fishermen themselves. It is a wide-mouthed bag net, more or less like a trawl without the latter's wings. The mouth is rectangular measuring 70 to 80 ft. on the head-rope and slightly smaller on the sole. The height is between 50 and 60 ft. The cotton net is mounted on a cotton rope of 25 plies, but the hemp is mounted on five or six thin hemp ropes running parallel (but not twisted) and secured at regular intervals. The length of the net from the centre of the sole to the cod-end is about 150 ft. though I have seen nets

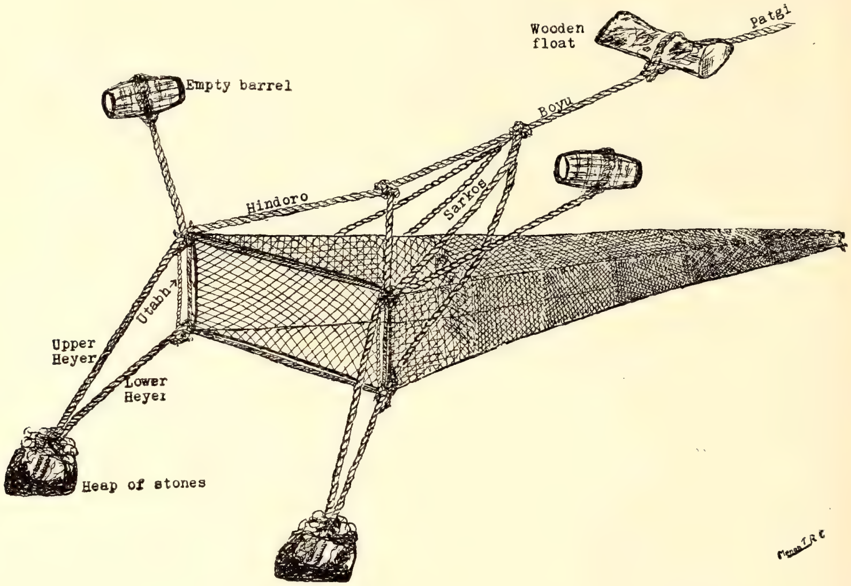

Fig. 2. 'Dol' net with all its accessory ropes in position. Except the wooden float all parts remain under water.

of 120 to 130 ft. length. The entire net is made up of five sections. Mesh size differs in each section and so also does the number of plies in the case of nets made up of cotton yarn. Table 1 gives the details of each section for the cotton net.

When the net is made of hemp, sections *Mhor* and *Chirate* are made of thicker twine while the rest is thinner. The cod-end of such nets is often double-meshed to give additional strength. The net used at Karanja (near Uran, Bombay State) is much larger than the one used on the Saurashtra Coast. This measures about 215 ft. long and about 120 ft. at the mouth. At present-day prices the smaller net costs about Rs. 900 while the larger one can be had for Rs. 1,200 (excluding labour charges). The nets have a service life of six to eight years during which they need only small repairs at negligible cost. They are regularly tanned in the bark of *Terminalia* species. The bark is boiled for four to five hours and the net, which has been thoroughly washed in fresh water, is kept immersed in the decoction for 10 to 12 hours. The nets are then dried in the sun. Tanning is done once in three months.

To keep the mouth of the net open, two wooden barrels are tied to the two upper corners while the two lower corners are either tied to two wooden poles or to two heaps of heavy stones. For the method employing wooden poles a reference may be made to Setna (1954). On the Saurashtra coast only stones are used. These stones are excavated from nearby quarries and supplied to fishermen through

TABLE I. Details of various sections of the Dol net (small size).

Gujarati name	*Madhar*	*Mathu*	*Nakhu*	*Soti*	*Zala* (*Zola*)	Remarks.
Marathi name	*Mhor*	*Chirate*	*Katra*	*Majola*	*Khola-Jhangar**	
Length ...	35 ft.	30 ft.	30 ft.	30 ft.	20 ft.	These measurements were taken from one net, but there is considerable variation.
Mesh size ...	12″ to 9″	9″ to 3″	3″ to 1·5″	1·5″ to ·5″	·5″	Mesh decreases from mouth to cod-end.
Cotton yarn no. 20½ s.	7 to 10 plies.	6 to 7 plies.	4 to 6 plies.	3 to 4 plies.	4 plies.	...

* The bag which follows the cod-end and remains untied is known by a separate name in Marathi (*Jhangar*) but in Gujarati the entire piece is known as *Zola*.

co-operative societies of stone-cutters. One net requires two heaps, each heap containing 30 to 40 stones, the weight of each stone varying between 80 to 100 lb. As one boat operates three nets at a time, it requires in all 180 to 200 stones. Formerly the fishermen had to pay anything between Rs. 60 to Rs. 80 per hundred of these stones but now, thanks to the co-operatives, they can get the same at Rs. 45 to Rs. 50 per hundred. The fishermen purchase the stones at the beginning of the season, use them for fixing their nets and leave them in the sea at the close of the season. Thus each boat loses about Rs. 100 to Rs. 125 per year on stones alone.

Operation of the net with these stones is an extremely complicated process. Each net is kept in position by a set of ropes of varying lengths, each rope having its own name and specific purpose. To the four corners of the mouth are tied four ropes called *Sarko*, each 40 yards long. These are permanently tied to the net and are used for shooting or hauling the net. Each *Sarko* is connected with the net in such a fashion that after making a fast knot with the net nearly a yard's length remains free (fig. 3). Other ropes form the bridle and remain in the sea once the bridle is set. These are as follows :

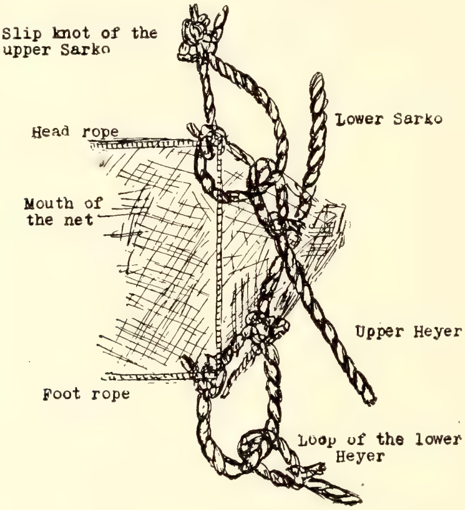

Fig. 3. A close-up of the mouth of the net showing the loops of the *Heyers* and slip-knots of the *Sarkos* of one side

1. *Heyer* of about 40 fathoms length.
2. *Utabh*, two, each 13 fathoms long.
3. *Hindoro* about 20 fathoms long.
4. *Boyu* about 30 fathoms long.
5. *Patgi* about 40 fathoms long.

Fig. 4 shows the positions of these ropes. The lengths given are those for the nets operating in Nawabunder waters. They vary with the depths of water and the dimensions of the net. Only the *heyers* are made of coir while the rest are made by fishermen themselves out of twisted Palmyra leaves. The cost will very much depend upon the lengths used, Palmyra ropes costing much less than the coir, but on an average each boat working off Nawabunder requires about Rs. 300 for the complete outfit.

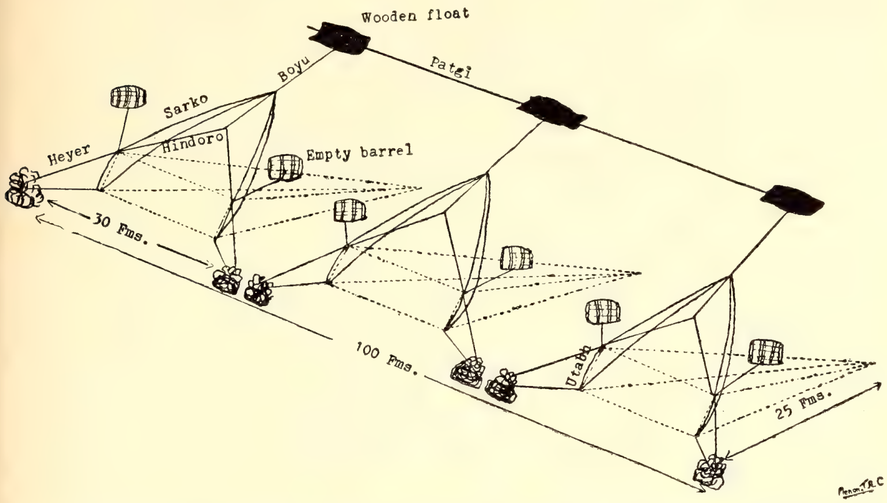

Fig. 4. General lay-out of three nets shot by one boat. The distance between the heaps of stones often exceeds 60 yards

4. THE BOAT

Fishermen of Gujarat who come from Bulsar, Bilimora, Kolak, Umarasadi, and other ports have much bigger boats than those of Saurashtra fishermen. 35 boats from different Gujarat ports were measured and gave the following mean values :

Overall length	42.6 ft.
Length between perpendiculars	35.2 ft.
Beam.	10.3 ft.
Depth (with the additional gunwale) ...	5.3 ft.
Additional gunwale	1.9 ft.
Aft Deck.	9.6 ft. long
For'ard Deck.	7.5 ft. long

The main mast stepped up almost in the centre is about 25 to 30 ft. long and carries only one fore-and-aft sail. A mizzen is sometimes carried much aft and is used mainly for steering. The vessels are carvel built with a square stern and with a stem of fairly wide angle. At Versova some of the boats are fitted with an outrigger consisting of two wooden bars 15 to 17 ft. long and one longitudinal piece about 12 ft. long, all made of pariza wood. No such outriggers have been noticed on any of the boats coming to the Saurashtra coast for Bombay-duck fishery. These boats without the outriggers cost in the neighbourhood of Rs. 4,000 and last more than forty years without major repairs. They are regularly painted on the outside with coal-tar and crude shark liver oil. Many boats at Versova and Satpati are mechanised. Inboard diesel engines of 25 to 30 B.H.P. are installed which give a service speed of about six to eight knots to the vessels when they are running free. They consume slightly over a gallon per hour and save considerable time in going to and from the fishing grounds which, on that coast, are between 30 and 45 miles away from the coast. Apart from propulsion the engines are not used for any other purpose, the shooting and hauling being done by manual labour as in ordinary craft.

5. Fishing Season and Operation of the Net

Fishing for Bombay-ducks on the Saurashtra coast starts towards the end of October and lasts till the following May. Off Jafrabad the season is of only four months' duration, but at Nawabunder and Rajpara fishing continues for six months. Gujarat fishermen establish temporary camps at these ports where they also cure the fish. Curing consists of only sun-drying the fish for two days. Two fish are interlocked by their jaws and hung on either side of a tightly stretched rope and left for two days. The fishermen employ local labour for this purpose.

After reaching the fishing ground the fishermen select their position by taking approximate bearings of some shore features. Each boat requires a space about 100 fathoms x 25 fathoms. Fig. 4 shows a general lay-out of the nets shot by one boat. When the place has been selected the boat is anchored. The *heyer* is doubled on itself and one big stone weighing at least 3 to 4 mds. is tied in its loop (fig. 5). The stone is now lowered in the water and the rope is paid out till it reaches bottom. The remaining stones are then

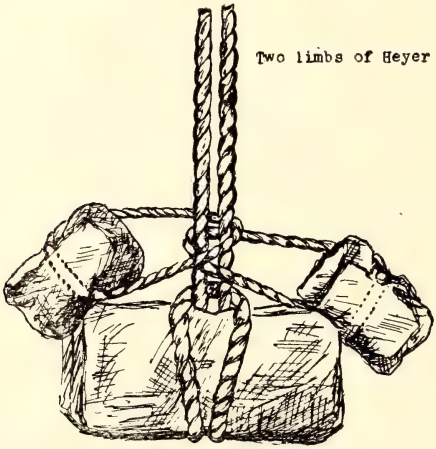

Fig. 5. The foundation stone and two subsidiary stones along with the two limbs of the *Heyer*

passed on to this stone. Each stone is tied to a small length of coir rope with a loop and this loop is threaded on to the two limbs of *heyer* (fig. 5). In this way all the thirty or forty stones are slid along on the first stone and the *heyer* is firmly anchored. It should be noted that the *heyer* does not directly come in contact with the stones and consequently there is no danger of it being cut by constantly rubbing against their edges. The two free ends of the *heyer* are now made into loops, and about a yard away from the loops both the limbs are connected by *utabh*. To the upper limb is also connected one end of *hindoro* which is lying in the boat. The boat now hangs on to the *hindoro* alone. The anchor is lifted and the boat proceeds about 60 yards (or less depending upon the width of the net's mouth) and drops another set of *heyer*, stones, and *utabh*. The other end of *hindoro* is made fast to the upper *heyer* limb of the second set. To the middle of the *hindoro* is now tied one end of *boyu* and the boat now proceeds to fix up the bridle for another net paying out the *boyu* as she goes. To the other end of *boyu* is tied a wooden float which is finally cast away. The bridle now settles down to the bottom, its position being indicated by the wooden float. As one boat operates three nets at a time, three such bridles are made ready and three floats are tied together by two pieces of ropes called *patgi* each of 80 yards length (fig. 4). The boat now returns to port and waits for a favourable tide.

The boat usually leaves the port on the flood tide and reaches the grounds before it starts ebbing. It locates its own set of floats and starts pulling the *boyu* of the extreme set towards the bridle. As the rope is pulled in at the bow it is again paid out at the stern so that it does not accumulate in the boat (fig. 6). As soon as the *hindoro* comes up the crew divide themselves, four of them pulling one limb of the *hindoro* in the bow and the rest pull the other limb in the stern. Soon the two upper *heyers* come up and by pulling the *utabh* the two lower *heyers* are also taken in, one set in the bow and the other set in the stern. The mouth of the net is now stretched so

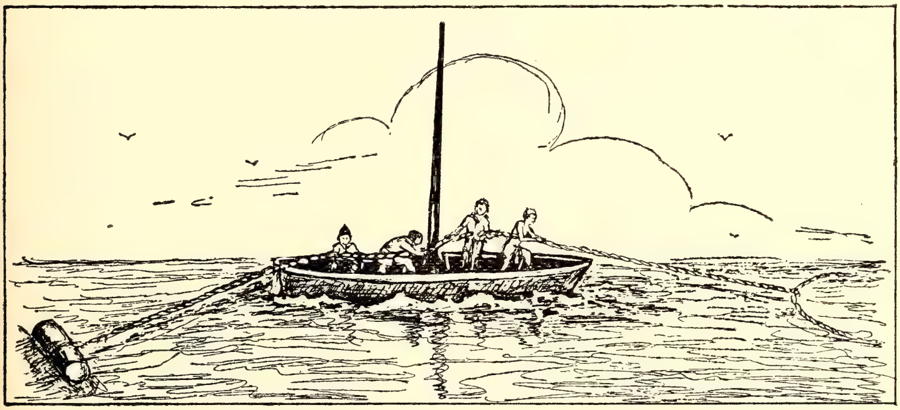

Fig. 6. Fishermen pulling the *boyu*. *Hindoro* is seen on the extreme right.

that one upper and one lower corner lie in the bow, the other pair in the stern. The end of the *sarko* which is tied to the net is now passed through the respective *heyer* loop and tied to the main rope by a slip knot (fig. 3). This slip knot is made in such a way that if *heyer* is pulled it would not give way, but if the *sarko* is pulled it will untie. The other ends of *sarkos* are tied to *boyu*. Sometimes two *sarkos* on one side are joined together before they are joined to the *boyu*. When all the four corners are ready the cod-end of the net is lowered in water. If the tide has turned the end will drift away fast, but if the waters are slack it will tend to sink instead of drifting away. The fishermen will shoot the net only when they are certain that there is a strong tidal current. The opening of the cod-end is closed by tying a string much in the same fashion as that of the trawl's cod-end, but about a yard from the end. Also attached to the cod-end is a rope known as *puthi*, the other end of which is attached to the middle of the sole of the mouth. This rope is about 60 yards long and serves the same purpose as that of the 'lazy line' of a trawl. Before paying away the net two barrels are attached to the two upper corners of its mouth. The net is finally cast away along with the bridle and soon sinks to the bottom due to its own weight. The boat now again pulls the *boyu* in the opposite direction till it reaches the *patgi* from which it finds out the next *boyu*. The operation is repeated and the second and the third net are shot. The boat is then made fast to the last *boyu* rope and rides virtually over that net. The fishermen now wait for the tide to flood again when they will haul in the net.

It appears from Dr. Setna's article that the 'Dol' net off the Bombay coast fishes a few fathoms away from the bottom, almost in mid-water region. So far as the Saurashtra coast is concerned it appears that the net fishes along the bottom. The foot-rope and the belly of the net is often smeared with mud and species of crabs, prawns, and other bottom fauna are always found in the catch. Similar species are also found in our trawl net which almost certainly fishes on the bottom. This difference in the levels at which the nets operate perhaps explains why the Bombay nets often get species like Pomfrets. At Madhwad (Kodinar) when the 'Dol' net fishermen see that the Drift netters are getting better catches of pomfrets, they shorten the ropes between the net and the barrels and also attach one barrel in the centre. This makes the net more buoyant and it fishes at a higher level thereby catching larger numbers of pomfrets. Confirmation of this important point is, however, necessary. A Kelvin's tube slid along a line tied to the lower *heyer* (or the lower *khera* in the case of the Bombay net) can indicate the depth at which the net is fishing.

With the turn of the tide hauling is started. The *boyu* is again pulled in the direction of the bridle. As soon as the *sarko* joints come up they are freed from the *boyu* and from now onwards only the *sarkos* are pulled, two of one side in the bow and the other two in the stern. The strain on the *sarkos* makes the slip knots give way, the *heyer* loops become free and the whole bridle sinks to the bottom while the net alone is pulled up by the *sarkos*. Once the mouth of the net is taken in, the remaining part of the net is hauled in like ordinary trawl and the cod-end released to get the catch out. I have never seen only the cod-end being pulled up as stated by Dr. Setna, nor is there any device in our nets to prevent spilling of the catch of the inverted net. After the catch is emptied the net is re-shot and the boat goes on to haul in the second net.

Usually the fishermen collect catches of two tides before returning to port, but sometimes, when the going is good, they wait also for the third tide; but this, more often than not, results in bringing highly deteriorated fish and the ultimate gain is almost nil. Each boat carries a crew of nine fishermen, each of whom has one net. There is a system of rotation by which one net is taken on board once in three days. The value of the catch is, however, equally divided amongst all the members after deducting the share of the boat-owner.

At the end of the season the *heyers* are cut as near the stones as possible and taken away. This is achieved with the help of a sickle-shaped instrument called *datardu* (fig. 7). Both the *heyers* are held together and pulled up taut. The *datardu* is put around both the ropes. On its convex side are attached two or three stones and a long string. The two ends of the crescent are tied by one string. Both these strings should be at least 30-40 yards long to ensure lowering of the *datardu* to the bottom. The *datardu* is now slipped along the *heyers* and it soon reaches the heap of stones on the sea-bottom. The string tied to the ends of the crescent is now held tight by the fishermen in the boat. The advantage of the wave action is taken in much the same way as described by Setna. When the boat goes in the trough the fishermen gather up as much of the string as possible and make it fast on the boat. When she rides a crest the *datardu* is

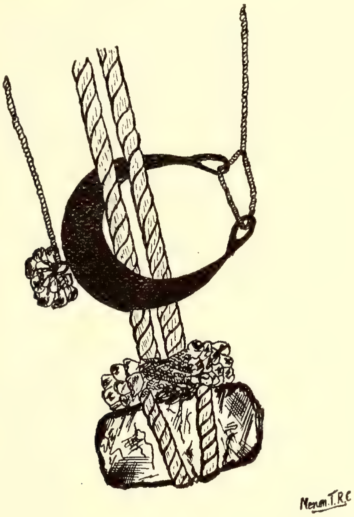

Fig. 7. The *Datardu* slipped around both the *Heyers*. The inner edge of the *Datardu* is sharpened like an ordinary sickle.

automatically brought down to bear upon the *heyers* and cuts them clean without any effort. The *heyers* and the *datardu* are then hauled in. Since the *heyers* are made of coir it would not be economical for the fishermen to lose them along with the stones; neither can they be left on the grounds as the wave action is bound to destroy them within a short time.

6. Conclusion

It will thus be seen that the method of operating the 'Dol' net in the Saurashtra waters is different than the methods employed off the Bombay coast. It is also noteworthy that though such a variety of ropes is used not one of them is superfluous. A pertinent question is whether mechanisation will help in this method. On the Bombay coast the fishing grounds are far away and naturally the machine has a distinct advantage over the sail; but off the Saurashtra coast the grounds are within twelve miles and as such a machine will not save much time. Moreover, the machine will occupy nearly one-third of the space available in the boat which will seriously hamper the operations. It may be argued that with the help of a machine the boat can return to port after every tide and thereby unload a better quality of fish. Unfortunately the ports from which this fleet operates are tidal ports and the boats will not be able to go right inside at the lower tides. Even supposing they manage to unload the catch by paying extra wages to the labourers, it will not make much difference because the catch has got to be sun-dried anyway and unloading six hours earlier or later will not appreciably alter the quality of the finished product. The engine will not be able to save any manpower either, because a mechanical winch or *gurdie* will certainly pull the ropes but the net will have to be hauled in by men, and a net of this size will require the full complement as carried by the boat at present. A mechanised boat will, however, have its own advantages. For one thing the fishermen will save considerable time in coming to the Saurashtra coast and going back home. This may give them a few days of additional fishing and more money. Secondly with a mechanised boat the fishermen will be able to try other types of fishing, such as drifting, after shooting the 'Dol' nets. A winch will haul the ropes quicker which ultimately will give extra fishing time. The Gujarat fishermen should, therefore, follow the example of their Satpati and Versova friends and get their crafts mechanised. Economic considerations should not come in the way as the Directorate of Fisheries of Bombay State are prepared to supply such engines at subsidised costs.

Another question worth considering is the charting of new grounds. As has been stated earlier, this Directorate's shrimp trawler has found thick shoals of Bombay-ducks in the Gulf of Kutch. Preliminary studies have shown that the fish caught in the Gulf have a higher mean-length than those of Nawabunder and a majority of them have gonads in ripe stages. Detailed investigations are now in progress on this species. Once the exact extent of the spawning season is ascertained the fishermen can be advised when to start operations. Already the Gujarat fishermen who come in the Gulf for Ghol-Dara

(*Sciaena—Polynemus*) fishery have started thinking on these lines and they will have no objection in undertaking this project which will increase Bombay-duck landings. Similar surveys will also be undertaken off Bhavangar and the Gulf of Cambay.

7. ACKNOWLEDGEMENTS

I am indebted to Shri G. S. Sartandel of the Daryawardi Magazine for furnishing me with details of the 'Dol' net used on the Versova and Karanja coast. Thanks are also due to Shri Budhia Naran, a fisherman of Kolak who took me on his boat and explained the process of shooting and hauling the net. I am obliged to Shri S. S. Shirsat of the Seth M. P. Shah Medical College and Shri T. R. Menon of this Directorate for drawing some of the sketches for me.

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NOTES ON SPECIFIC IDENTIFICATION IN THE TAWNY PIPIT (*ANTHUS CAMPESTRIS*), BLYTH'S PIPIT (*A. GODLEWSKII*), AND RICHARD'S PIPIT (*A. NOVAESEELANDIAE*) IN ASIA

BY

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(*With a text figure*)

In India in winter three species of pipit are found which are particularly difficult to tell apart in the hand. They are the Tawny Pipit, *Anthus campestris* (Linnaeus), which in Asia breeds from Turkey and Palestine north and eastwards to the region of Krasnoyarsk, migrating to Arabia and India; Blyth's Pipit, *A. godlewskii* (Taczanowski) (formerly *A. striolatus* or *A. thermophilus*), which breeds in Mongolia, Shensi, and Assam, migrating to India, Ceylon, Burma, western Yunnan, and the Andaman Islands; Richard's Pipit, *A. novaeseelandiae* (Gmelin), which breeds throughout most of central, eastern, and southern Asia, the northern races migrating into the territory of the non-migratory races in India, Burma, Ceylon, the Andaman Islands, Thailand, and Indo-China. In identifying birds taken in their winter quarters the necessity of distinguishing between the migratory and non-migratory races of Richard's Pipit is added to the difficulty of specific identification.

In the course of re-sorting specimens of these species in the British Museum it has seemed to me that the difficulties of identification have been enhanced by a tendency in standard works to place too much emphasis on the diagnostic value of single characters rather than on a combination of characters, and by lack of detailed measurements of all forms. The necessity of measuring about a thousand Asian specimens has enabled me to prepare a comprehensive table of measurements for all the forms except some races of Richard's Pipit from central Asia which are poorly represented in London. It is hoped that this table and some notes on the diagnostic value of various characters may aid others in the identification of specimens.

Before discussing specific identification it is necessary to understand the geographical variation in Richard's and the Tawny Pipit. (None is known in Blyth's Pipit.)

Variation in Richard's Pipit in Asia.

Richard's Pipit in Asia varies more significantly in size than in colour, most of the populations falling into two size-groups: the first consists of the large migratory races, *A. n. richardi* Vieillot, *A. n. centralasiae* Kistjakowaskij, *A. n. dauricus* Johansen, and *A. n. ussuriensis* Johansen: the second consists of the small non-migratory races, *A. n. waitei* Whistler, *A. n. rufulus* Vieillot, and *A. n. malayensis* Eyton. There is little overlap in measurements between these groups but birds with wings of 86 or 87 mm. could be either male non-migrants or female migrants: this is stressed since some works give 90 mm. as the shortest wing of migrants of either sex.

These two groups are linked by the semi-migratory *A. n. sinensis* (Bonaparte) breeding in southern China and wintering in Indo-China and Thailand. It will be seen from the table that this form is not wholly separable from either group but correct sexing and comparison of all measurements serve to distinguish most specimens. In central Annam there is another breeding population which is intermediate between the two groups in size. No purpose would be served in giving this intermediate population a name but it has been listed separately in the table since some specimens are distinct in dimensions from those of any other race.

The extent of geographical variation in colour or size in the migratory races cannot be assessed without long series of breeding birds; and few workers agree on the ranges and characters of the described races. With only twenty-four specimens available from the breeding areas I have therefore made no attempt to distinguish between these races: even when the variations are fully understood it is doubtful if it will be possible to refer confidently more than a small percentage of winter migrants to one or another.

The non-migratory races vary little in size; in colour they show a certain amount of variation between local populations in the general colour of the backs, but over large areas the races are separable only on broad lines, as C.M.N. White has found in the African races (*Bull. Brit. Orn. Cl.* 1957: 31). *A. n. waitei* of north-western India is generally the greyest and least heavily streaked above and below; *A. n. malayensis* of Ceylon and continental Asia south of lat. 14° S. is the most rufous and most heavily streaked; *A. n. rufulus* is intermediate between them and merges into them gradually.

Variation in the Tawny Pipit.

Some workers consider the Tawny Pipit monotypic, some recognise two races on size, some two on colour. Adults vary in having the mantle grey to light brown with light or very light streaking, and in having the breast unstreaked or lightly streaked. Wings of males vary from 85 to 101 mm. From the evidence of British Museum specimens the variation in colour seems individual, or possibly associated with local breeding populations, rather than broadly geographical, but with streaky-breasted and greyer birds more common in the east than in the west.

Size variation is not yet fully understood. Wings of males in the British Museum are as follows:

	Summer	*Winter*
Europe,[1] N. Africa, Middle East	88-93	88–101
Western India		85–96
Eastern India (United Provinces, Bihar)		85-90
Tian Shan (2 specimens)	94-95	
Krasnoyarsk (2 specimens)	85	

From these measurements it is apparent that western birds are variable, averaging large, but there is a consistently smaller population in the east which winters throughout India. Only these smaller birds are found in United Provinces and Bihar but they mix with larger birds in the western provinces. They have generally been distinguished in the past as *A. c. griseus* Nicoll, described from Tian Shan. However, six specimens from Tian Shan are no smaller and not consistently greyer than European birds and I agree with those who consider *A. c. griseus* a synonym of *A. c. campestris*. It seems probable that the smaller birds come from further north and may be wintering birds of *A. c. kastschenkoi* Johansen, which was described as a small pale race (wings of males 85-92 mm.) breeding from Novosibirsk to Krasnoyarsk. Whether it is useful or not to attempt to differentiate between *kastschenkoi* and the nominate race may be resolved when a large series of breeding birds from all parts can be assembled together. As Vaurie (op. cit.) points out *kastschenkoi* probably represents merely the end of a cline in size and perhaps colour, and a high proportion of migrants must always be indeterminate. The name has been retained here, the measurements given for it being based on the specimens from eastern India and Krasnoyarsk, since it seems important that the existence of this consistently small population should be realised. Furthermore it is only these small birds among the Tawny Pipits that can present some difficulties in identification.

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[1] Vaurie gives 86–98 for European ♂♂s. (Amer. Mus. Nov. 1672, 1954 : 9)

Specific identification.

In the three species there is no single character by which all specimens of one species may be distinguished from the other two, but there are four important characters which, combined, serve for identification. These are :

1. *Pattern of body plumage.* The lack of streaking on the breast in most adult Tawny Pipits enables them to be distinguished at a glance from the streaky-breasted Richard's and Blyth's Pipit. The remainder, and young birds, which have light streaking, are sufficiently distinct to be distinguished by eye alone from Blyth's Pipit and most races of Richard's Pipit, but many individuals of the smaller *A. c. kastschenkoi* cannot be so distinguished from the most lightly streaked race of Richard's Pipit, *A. n. waitei*, in north-western India.

In Blyth's Pipit the colour and pattern of body plumage are so like many specimens of Richard's Pipit that individuals cannot be distinguished by eye, though, in series, Blyth's Pipit will be found to have the streaks on the back and breast more clearly defined, though not necessarily heavier.

2. *Hind Claw.* The importance of the hind claw in specific identification has long been recognised. In particular the long and straighter hind claw of Richard's Pipit has been selected as a diagnostic character in contrast to the short, curved claw of the Tawny Pipit, and, in lesser degree, of Blyth's Pipit: but it should be understood that in all species individuals are found with abnormally long, or abnormally short hind claws. The latter are possibly due to excessive wear or breakage: the former are represented by specimens of Richard's Pipit with claws over 18 mm., of Blyth's Pipit with claws over 14 mm., and of the Tawny Pipit with claws over 11 mm. Sole reliance on the hind claw for identification can, therefore, on occasion lead to error.

3. *Relative length of wing and tarsus.* The long tarsus of Richard's Pipit has also been stressed as a diagnostic character distinguishing this species from the other two, but it varies between races and should, therefore, always be considered in conjunction with the wing length. Thus the migratory races of Richard's Pipit have a longer tarsus than the Tawny Pipit and Blyth's Pipit but a similar length wing, while the non-migratory races have a similar length tarsus to the other two species but usually a shorter wing. Particular care should be taken in identification of specimens with a tarsus of 28 mm. The variation in the wing/tarsus ratio of each form has been included in the table since this ratio is frequently of greater importance than the single measurements.

4. *Tail Pattern.* In all three species the outermost pair of rectrices are largely white and the next pair have a pattern of white that varies individually and sometimes asymmetrically. Because of this individual variation a small but significant difference in pattern between Blyth's Pipit and the other two species has not been fully appreciated. Usually in Blyth's Pipit the outer web of this second pair of feathers is white, and the white on the inner web is triangular, broad at the tip of the feather and tapering sharply into the shaft (figs. 5 & 6). By contrast in Richard's Pipit and the Tawny Pipit the white on the inner web usually takes the form of a stripe alongside the shaft, not broadening significantly at the tip of the feather (fig. 2). Sometimes in Richard's Pipit, particularly in the migratory races, the edges of the pattern are not well-defined, the white merging into the brown (fig. 1). In all these species exceptional birds have much less white on the feathers but the basic shape of the pattern is usually still recognisable (Figs. 3, 4, & 7). However, until some familiarity with these patterns and variations has been gained they are not easy to recognise in single skins and it is wise to use the tail pattern only as confirmatory to other characters in identification.

Summary of diagnostic characters.

Most adults of the Tawny Pipit can be distinguished from the other two species by lack of spotting on the breast. The remainder, and young birds, can be confused visually with *A. n. waitei* but are generally larger, with a shorter, more curved hind claw, a higher wing/tarsus ratio while in series, the bills and legs are paler in the dried skin.

Blyth's Pipit can be distinguished from Richard's Pipit by the wing/tarsus ratio by the tail pattern, and by having usually a shorter hind claw, always under 18 mm.: and from all specimens of the Tawny Pipit by the heavier streaking. In addition it has a different tail pattern and usually longer hind claw.

Status of Blyth's Pipit.

Currently Blyth's Pipit is frequently considered to be conspecific with the Tawny Pipit. Although it replaces the Tawny Pipit in eastern Asia I consider that its distinctive appearance, different tail-pattern, longer hind claw, and lack of any intergradation with the Tawny make it advisable to treat the two birds as separate species.

Table of Measurements and Main Characters of the Tawny Pipit, Blyth's Pipit, and Richard's Pipit in Asia

(based on specimens in the British Museum, with a minimum of 15♂ and 15♀ of each form unless otherwise stated)

		Wing		Bill		Tail		Hind Claw		Tarsus		Wing/ Tarsus Ratio	Streaking		Tail pattern
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂ & ♀	above	below	
Richard's Pipit	*A. novaeseelandiae* ... *richardi* *centralasiae* *dauricus* *ussuriensis*	90–102	86–97	18–21	17–19	63–73	62–71	15–27	14–19	28–33	28–33	2·9–3·3	heavy	heavy	figures 1–4
	A.n. sinensis ... (8♂ 8♀ summer)	87–91	81–88	17–18	16·5–18	58–64	55–62	12–19	14–17	28–30	27–30	2·9–3·1	,,	,,	,,
	Central Annam ... population (6♂ 5♀)	80–90	80–86	16·5–17	16–17·5	57–62	54–59	10–18	12–16	26–29	27–28	2·9–3·2	,,	,,	,,
	A.n. rufulus ...	78–87	75–83	16–17	15·5–17	54–61	51–56	10–18	11–16	25–28	25–26	2·9–3·3	,,	,,	,,
	A.n. waitei ... 10♂ 10♀)	77–86	75–82	16–17	15–17	51–58	49–56	11–17	12–15	25–28	24–27	2·8–3·3	less heavy	less heavy	,,
	A.n. malayensis ...	77–86	74–83	16–18	16–18	51–58	50–56	12–18	12–18	25–28	25–28	2·7–3·4	very heavy	very heavy	,,
Tawny Pipit	*A.c. campestris* ... (see text) ...	88–101 (86)	82–91	18·5–20	17–20	61–67	59–66	10–13 rarely	9–14 over 11	25–28	24–26	3·3–3·8	very light or light	none or light	figures 2–4
	A.c. kastschenkoi ... (see text)	85–90	80–87	17–18	16–17	55–65	54–61	8–13	8–10	24–26	23–26	3·4–3·7			
Blyth's Pipit	*A. godlewskii* ...	90–97	84–93	16·5–18	16–17·5	62–70	59–64	11–17 rarely	11–17 over 14	25–28	24–27	3·2–3·8	heavy	heavy	figures 5–7

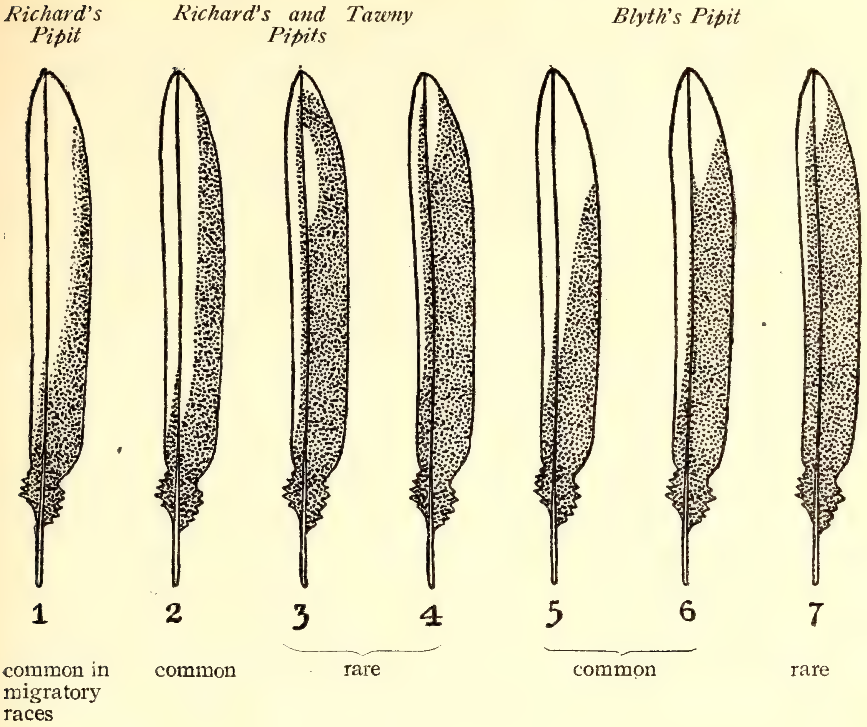
Richard's Pipit
Richard's and Tawny Pipits
Blyth's Pipit
1
2
3
4
5
6
7
common in migratory races
common
rare
common
rare

FIGURE: Second outermost tail feathers of Blyth's Pipit, the Tawny Pipit, and Richard's Pipit in Asia, showing common patterns and extremes of variation.

A SYSTEMATIC ACCOUNT OF THE EELS OF BOMBAY

BY

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(With fourteen text figures)

INTRODUCTION

Eels form an important fishery in different parts of the world and they have attracted the attention of naturalists since the beginning of this century, when the Danish scientist Johannes Schmidt (1906) made the sensational discovery of the breeding migration of the European eel. They are a fairly large group of fishes, represented by a number of genera and species. Day (1889) recorded 42 species of eels belonging to 13 genera and 2 families from Indian waters, and subsequent workers have added a few more to this list. On the Bombay coast Hefford (1922) recorded two species of eels in the catches of the steam trawler 'William Carrick', and Sorley (1922) eight species during his general survey of the fisheries of the Bombay State. Fowler (1932) placed on record two species of eels from Bombay. However, a full account of the taxonomy of the anguilliform fauna of Bombay water is not available, and hence an attempt has been made here to describe the various species of marine eels occurring along the Bombay coast. For this purpose, collections of eels were made regularly from Sassoon Dock and Versova, two fish landing centres which contribute greatly to the fish supply of Bombay City.

The observations made during the course of this investigation show the occurrence of fourteen species belonging to seven genera and five families. Four of these, namely *Muraenichthys gymnopterus* (Blk.), *Pisoodonophis cancrivorus* (Rich.), *Ophichthys cephalozona* (Blk.), and *O. apicalis* (Benn.) are being reported for the first time from the Bombay Coast. Of the eight species recorded by Sorley (op. cit.), only five are found in this collection.

KEY TO THE SPECIES RECORDED[1]

1.	Caudal present ...	2
	Caudal absent ...	12
2.	Posterior nostril below eye in the form of a valve in the upper lip ...	*Muraenichthys gymnopterus*
	Posterior nostrils superior or above the level of eye ...	3
3.	Pectorals present ...	4
	Pectorals absent ...	7
4.	Teeth multiserial, pharyngeal openings wide slits ...	5
5.	No canines in the jaws ...	*Uroconger lepturus*
	Canine teeth in the jaws ...	6

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[1] The generic and specific names given here are according to Weber and de Beaufort (1916).

6.	Outer row of teeth in mandibles directed outwards ...	*Muraenesox talabonoides*
	Outer row of teeth in mandibles not directed outwards ...	*Muraenesox cinereus*
7.	Head and trunk 1½ times or more than tail ...	*Thyrsoidea macrurus*
	Head and trunk more or less equal to tail ...	8
8.	Mesial teeth on intermaxillary teeth, not longer than the peripheral series ...	*Muraena* (*Gymnothorax*) *picta*
	Mesial teeth on intermaxillary place, long and fang-like ...	9
9.	Maxillary teeth in two or three series ...	*Muraena* (*Gymnothorax*) *meleagris*
	Maxillary teeth in single series ...	10
10.	Head and body with large jet-black spots separated from one another with narrow yellowish reticulations ...	*Muraena* (*Gymnothorax*) *favaginea* var. *favaginea*
	Head and tail with dull yellowish reticulations on brown background ...	11
11.	Well defined reticulations all over body, tail considerably shorter than head and body ...	*Muraena* (*Gymnothorax*) *pseudothyrsoidea*
	Lines on body and tail not well defined. Tail longer than the head and trunk ...	*Muraena* (*Gymnothorax*) *undulata* var. *undulata.*
12.	Teeth granular and in bands ...	13
	Teeth conical and acute ...	14
13.	Origin of dorsal behind end of pectorals ...	*Pisoodonophis boro*
	Origin of dorsal above middle of pectorals ...	*Pisoodonophis cancrivorus*
14.	Head and trunk more or less equal to tail ...	*Ophichthys cephalozona*
	Head and trunk 1½ or more in tail ...	*Ophichthys apicalis*

Notes on the Species

Muraenichthys gymnopterus (Bleeker).

This eel is rarely found in this locality and only one specimen, 433 mm. long was obtained from among the shrimp catches landed at Versova by bag nets from a depth of about 11 fathoms. Its colour was yellowish brown in fresh condition. The species is characterised by the anus being situated in the front half of the total length, and by the valve-like posterior nostrils in the upper lip beneath the eyes.

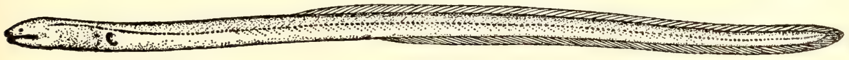

Fig. 1. *Muraenichthys gymnopterus* (Bleeker)

Day (1889) recorded two species belonging to this genus, viz. *M. schultzi* and *M. vermicularis* from Indian waters, while *M. gymnopterus* is reported here for the first time from India. The maximum size of this species recorded so far is only 266 mm. It has a fairly wide distribution and has been reported from South Africa, Ceylon, Java, Celebes, Philippines, and China (Weber & Beaufort, 1916).

Uroconger lepturus (Richardson).

This eel, known as 'tolaka' in Marathi, is commonly found in bag net catches both at Sassoon Dock and Versova. Being a small fish growing to a maximum length of about 400 mm., it is never obtained from the long line catches. Although the species is edible it has no commercial value and is generally used as bait for long line fishing. It is easily recognised by its dark brownish colour and whip-like tapering tail. The lateral line has a row of whitish spots. The largest size recorded during the course of this investigation is 284 mm.

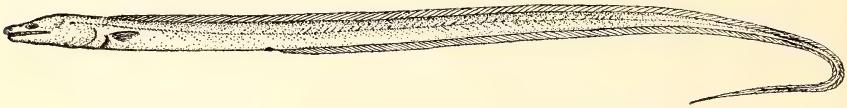

Fig. 2. *Uroconger lepturus* (Richardson)

Fowler (1927) appears to be the first to record this species from Bombay, though Day (1889) has recorded it from Indian waters. Nair (1946) collected its adults and larvae from the Madras coast. It has a widespread distribution and is reported from Oman, the seas of India, Ceylon, Java, Celebes, Sumatra, Philippines, and the China Sea.

Muraenesox talabonoides (Bleeker).

This species, which is the commonest of all the eels of Bombay, constitutes a very important fishery and it commands a good market, being an important food fish. It is generally landed by the hook and line fishermen and also by the trawlers. This fish is golden yellow in colour and is characterised by having externally directed teeth in the mandibles.

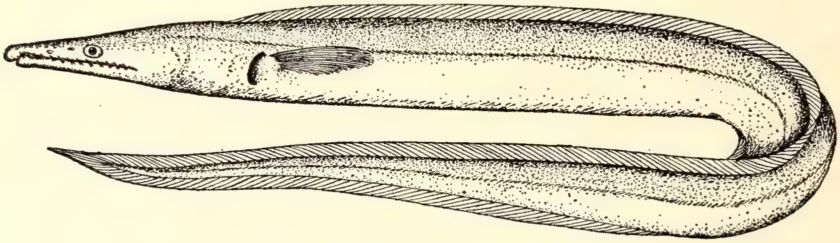

Fig. 3. *Muraenesox talabonoides* (Bleeker)

M. talabonoides is a tropical fish, not so widely distributed as the other two species of the genus. Day (1889) commented on its rarity in the Indian waters. The present investigation, however, shows that it is very common in Bombay waters, as noted by Sorley (1932) and Hefford (1922). The maximum size recorded is 2,080 mm.

Muraenesox cinereus (Forskal).

This fish ranging up to about 1,428 mm. in length is found in small numbers in the commercial catches landed at Sassoon Dock and Versova. It is generally caught with the hook and lines and occasionally in the bag nets as well as in the trawl nets. It has a dull white colour becoming fairly dark dorsally. The mouth is long with a drawn out snout. The species is characterised by the presence of strong canine teeth with basal lobes on the vomerines. It is considered to be a good food fish and is locally known as 'wam', a name which it shares with *M. talabonoides*. The larval forms and the elvers of *M. cinereus* are also obtained in fair numbers from Sassoon Dock and Versova in April and May. They are found mixed up with shrimp catches landed by the bag nets from approximately 10 to 11 fathoms.

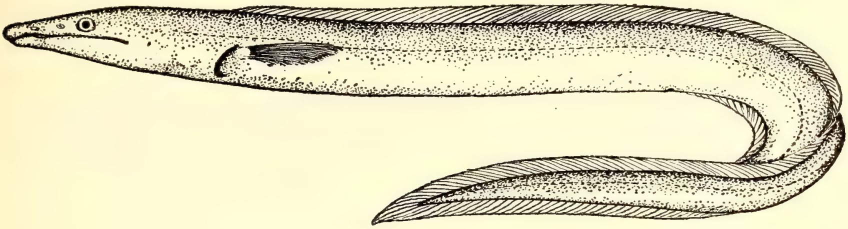

Fig. 4. *Muraenesox cinereus* (Forskal)

Day (1889) observed that this is the most common of the *Muraenesox* species in Indian waters. Hegord (1922), Fowler (1927), and Sorley (1932) have noted its occurrence in Bombay waters in small numbers. Nair (1947) obtained the larvae and the adults of this fish from Madras waters. In addition, the numerous hauls taken by the trawlers along the Kathiawar coast tend to show occasional occurrence of this species, although the major portion of the eel catch comprises *M. talabonoides*.

The species has a very wide distribution and is recorded from most of the places of the Indo-Australian Archipelago, east coast of Africa, Red Sea, coasts of India, Ceylon, Philippines, China, and Japan.

Thyrsoidea macrurus (Bleeker).

This species is occasionally found among the long line catches of Sassoon Dock and Versova. It has a very elongated body, deep brown in colour, and the largest specimen taken during this study was 1,686 mm. long. This species is consumed exclusively by the poorer people and does not constitute a fishery along this coast.

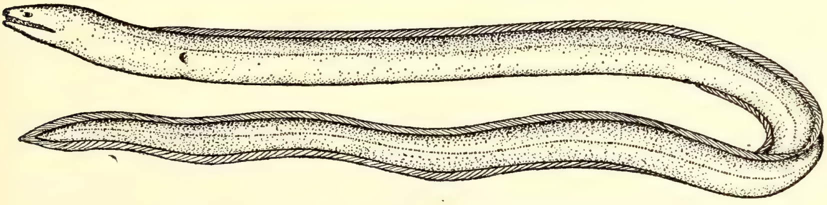

Fig. 5. *Thyrsoidea macrurus* (Bleeker)

Day (1889) reported this species as *Muraena macrura* from Indian waters but it was not recorded before from Bombay waters. It is known to occur in South Africa, Ceylon, Madras coast, the Andamans, New Guinea, and Formosa. Nair (1947) recorded its larval forms from the Madras plankton.

Muraena (Gymnothorax) picta Ahl.

This is a fairly common eel in the inshore waters of Bombay and is generally obtained both in the long line and bag net catches. It is not eaten and the fishermen consider its bite to be poisonous. Its characteristic colour is mottled brown on yellowish background. There is considerable amount of irregularity in the arrangement of the spots and consequently different patterns of colour can often be noticed within the species. The maximum size recorded here is 623 mm.

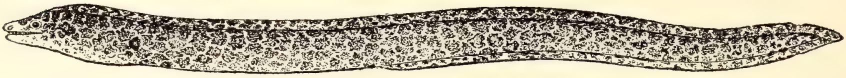

Fig. 6. *Muraena* (*Gymnothorax*) *picta* Ahl.

Day (1889) noted the occurrence of this species (*Muraena picta*) in Indian waters and Sorley (1932) from the Bombay State. It has a very wide distribution, being reported from South Africa, East Africa, Madagascar, south Arabia, seas of India, Ceylon, Malaya, Philippines, Australia, and West Pacific Islands.

Muraena (Gymnothorax) meleagris Shaw.

This species known as 'killis' in Marathi is frequently obtained in the long line and bag net catches. Small sized specimens occur quite often among the shrimp catches both at Sassoon Dock and Versova. It is brown in colour, with deeper brown spots all over the body. This fish has no commercial importance except that it is consumed by the poor class of people. Normally it is used as bait in the long line fishing. The fishermen consider the bite of this species also poisonous. The sizes recorded during these observations range from 312 mm. to 897 mm. in length.

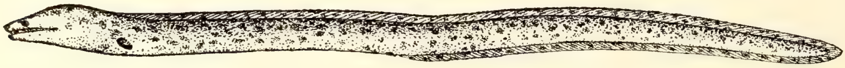

Fig. 7. *Muraena (Gymnothorax) meleagris* Shaw

Though it has been recorded as *Muraena meleagris* by Day (1889) from the seas of India, till now there seems to be no definite record of its occurrence in Bombay waters. The distribution of *meleagris* is very wide as it occurs in South Africa, East Africa, Seychelles, Mauritius, India, Malay Archipelago, and the Pacific.

Muraena (Gymnothorax) favaginea Bloch and Schneider.

This is the tesselated eel very frequently observed in Bombay and its neighbourhood. It has a jet black colour with well defined reticulations of yellowish white lines making a completely tesselated appearance. Specimens of this fish are quite often obtained in the shore seines, operating in shallow waters with rocky bottom. It is considered to be non-edible and poisonous. This species is also an attractive aquarium fish and a number of them are displayed in the

Taraporevala Aquarium at Bombay. There is no fishery for this species in the locality. The maximum size observed is 863 mm.

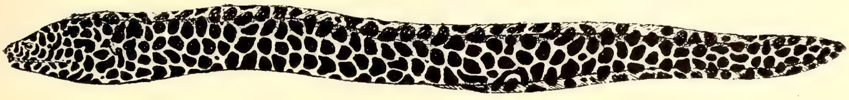

Fig. 8. *Muraena (Gymnothorax) favaginea* Bloch and Schneider

Day (1889) has recorded it from Indian waters in the name of *Muraena tesselata* and Sorley (1932) from Bombay waters. Besides, it has been reported from the east coast of Africa, Mauritius, south Arabia, Malay Archipelago, Sumatra, Singapore, New Guinea, and China.

Muraena (Gymnothorax) pseudothyrsoidea (Bleeker).

This is a very common eel in Sassoon Dock and Versova, generally obtained in long line as well as in bag net catches. The species has light brownish spots on the head and body with dull yellowish lines or reticulations in between. It is also known as 'hessal' in Marathi. It is not edible and as such has no economic significance. However, this fish is often used as bait in the long line fishing. The largest size noted during the present investigation is 605 mm.

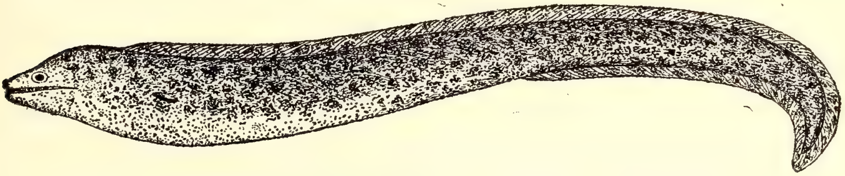

Fig. 9. *Muraena (Gymnothorax) pseudothyrsoidea* (Bleeker)

This species has been recorded by Day (1889) from Indian waters and Sorley in Bombay waters. Its distribution extends from the Sind coast and India to the Seychelles, Malay Archipelago, Philippines, and China.

Muraena (Gymnothorax) undulata undulata (Lacépède).

This species is very common in the rocky inshore areas of Bombay and many specimens are kept in the Taraporevala Aquarium. The fish has a mottled appearance with reddish brown blotches on dull white background. One specimen collected from deeper waters by a long line fisherman at Sassoon Dock measured 682 mm. In Marathi it is

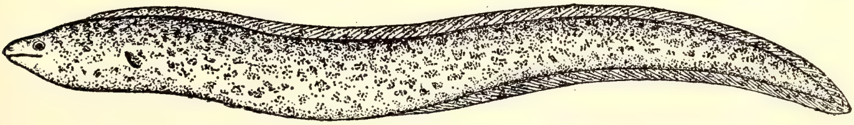

Fig. 10 *Muraena (Gymnothorax) undulata undulata* (Lacépède)

known as 'hessal'. Apart from the fact that it is a good and hardy aquarium fish, it has no commercial value.

It has a very wide distribution, being reported from South Africa, east coast of Africa, Madagascar, Mauritius, Red Sea, seas of India, Ceylon, Andaman Islands, Malay Archipelago, Philippines, Pacific Islands, and China.

Pisoodonophis boro (Hamilton-Buchanan).

Two specimens, one from a rock pool near Cuffe Parade and another from Dadar beach, were obtained during this study. The species is a burrowing form which is not normally met with in the commercial fish catches of this locality. It is easily distinguished by the absence of caudal fin and by the presence of bands of granular teeth on the jaws. The origin of dorsal is far behind the end of the pectorals. The body of the fish is dark grey while the median fins are whitish.

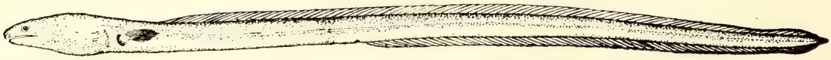

Fig. 11. *Pisoodonophis boro* (Hamilton-Buchanan)

Being a very common eel in the fresh and brackish waters of India, it has been recorded by Day (1889), Ayyar (1932), Hora (1933), Aiyar *et al.* (1944), George and Desai (1944), and Chacko and Srinivasan (1954) from various parts of India. It is a widely distributed species and is known to occur in South Africa, east coast of Africa, India, Ceylon, Sumatra, Singapore, Java, Celebes, New Guinea, and Formosa.

Pisoodonophis cancrivorus (Richardson).

This is a rare eel in this locality and is represented by only two specimens in the present collection. When fresh, it has a dark brown hue dorsally, and is light brown on the ventral aspect. The dorsal fin originates above the middle of the pectorals. The teeth are found in bands of several rows, the intermaxillary being arranged in a separate group from the rest. The tail is about 1½ times longer than the rest of the body.

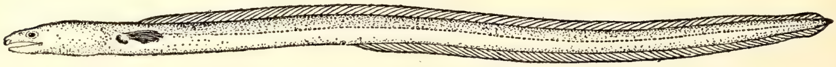

Fig. 12. *Pisoodonophis cancrivorus* (Richardson)

There is so far no record of this species from Indian waters, although its known distribution is very extensive. It is recorded from South Africa, Madagascar, Arabia, Ceylon, Penang, Singapore, Celebes, Samoa, Australia, Philippines, China, and Japan.

Ophichthys cephalozona (Bleeker).

This is a fairly common eel in the bag net catches landed at Versova. It seldom occurs in the long line catches and has no regular fishery in Bombay. The body is purplish brown and the deep cross band on the nape described by various authors appears to be less conspicuous due to the deep brown colour of the body. The maximum size recorded is 830 mm., while the largest specimen in the present collection measured only 442 mm. in length.

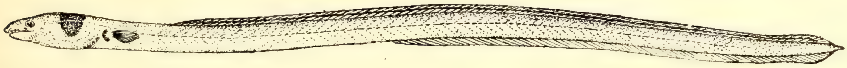

Fig. 13. *Ophichthys cephalozona* (Bleeker)

There is no previous record of this species from Indian waters. It has a widespread distribution in the Indo-Pacific region having been recorded from Singapore, Ambon, Ceram, New Guinea, Philippines, Australia, China, Formosa, and Japan.

Ophichthys apicalis (Bennett).

This species, locally known as 'devar' is fairly abundant in Sassoon Dock and Versova, being caught always in the long line catches. It is available throughout the year at both these places and generally occurs along with the small shrimp catches. It is a small vermiform fish with greenish tint in fresh condition. Ventrally the colour is more whitish. The tail is more than 1½ times the length of the rest of the body. Dorsal commences from above the origin of pectoral. The teeth are uniserial but vomerines are irregularly distributed. The maximum size recorded is 430 mm., the largest specimen observed at Bombay measuring 308 mm. in length.

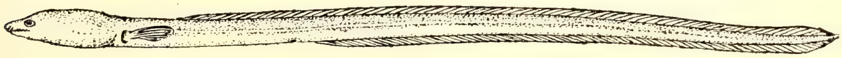

Fig. 14. *Ophichthys apicalis* (Bennett)

This species is also not recorded from Indian waters so far, although it has been reported from South Africa, Madagascar, Ceylon, Singapore, Java, Celebes, Philippines, and China.

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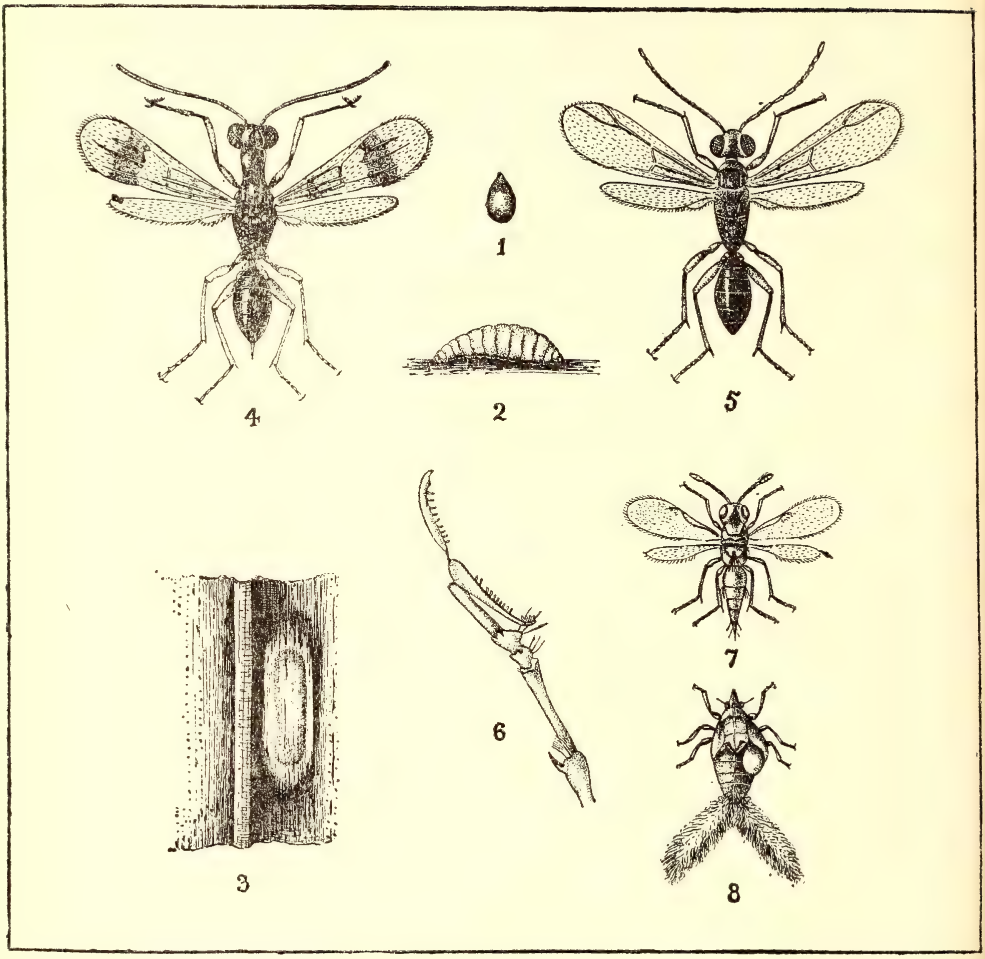

EXPLANATION TO PLATE

Fig. 1. Egg of *Lestodryinus pyrillae* Kieffer.

Fig. 2. Fully developed *Lestodryinus* grub after emergence from the thylacium preparing to spin the cocoon.

Fig. 3. Cocoon of *Lesodryinust pyrillae* on sugarcane leaf.

Fig. 4. Adult female of *Lestodryinus pyrillae* Kieffer.

Fig. 5. Adult male of *Lestodryinus pyrillae* Kieffer.

Fig. 6. The modified foreleg of the female Dryinid.

Fig. 7. Hyperparasite: *Cristatithorax quadricolor* Gir.

Fig. 8. Parasitised *Pyrilla* nymph showing the development of the thylacium between the wing pads.

THE BIOLOGY AND BIONOMICS OF *LESTODRYINUS PYRILLAE* KIEFF. (DRYINIDAE: HYMENOPTERA) A NYMPHAL PARASITE OF *PYRILLA PERPUSILLA* WALK., AND A NOTE ON ITS ROLE IN THE CONTROL OF *PYRILLA*[1]

BY

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(*With a plate*)

At the present day, sugarcane is grown in an area of well over three million acres. But this increase has brought the problem of insect pests to the forefront. While modern insecticides have their usefulness in pest control, their indiscriminate use also results in the extermination of the natural enemies which keep in check the pests in nature. With the mass destruction of these natural enemies attributable to the extensive use of modern insecticides, the pests which used to appear periodically in an epidemic state have now become a regular feature in the sugarcane tracts of the Indian Union. This is what has happened in the case of the Sugarcane Leaf-hopper *Pyrilla perpusilla* Walk. This pest was seen in an epidemic state only once in a few years formerly, but of late its outbreaks have become an annual feature. The present paper deals with the bionomics of *Lestodryinus pyrillae* Kieff. an important nymphal parasite of *Pyrilla perpusilla.* Except for Misra's (1917) account of the biology of *Chlorodryinus pallidus* Perkins, no work has been done on the biology of any Indian Dryinid.

Material and Methods

(*a*) Breeding of the Host:

As *Lestodryinus pyrillae* Kieff. is a parasite of the nymphal stages only, it was necessary to maintain a culture of *Pyrilla* so that any number of nymphs might be available at all times for these investigations. For this purpose a field cage made of teak-wood frames and wire-gauze doors and panels on the sides and back were used. The cage had a base of box-like structure in which soil was packed. Both in February and in October the sugarcane setts were planted. Eight such cages were prepared and in each cage a pair of mated *Pyrilla* were released for egg-laying. The eggs hatched out into nymphs and the nymphs were used for breeding the parasites.

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[1] Part of a thesis approved for the award of the degree of Doctor of Philosophy of the University of Mysore.

(*b*) BREEDING OF THE PARASITE:

A culture of *L. pyrillae* was built from a single pair of male and female pupae collected from the sugarcane fields in the farm of the Indian Agricultural Research Institute, New Delhi. As the parasite is able to complete its development and emerge as adult when the host nymphs parasitised are of the second, third, or fourth stage, only such nymphs were collected from the field cages and exposed for parasitisation in tubes. One, or sometimes two, nymphs were introduced into the tube at a time and, as soon as they were parasitised, the nymphs were removed to another tube and fresh sugarcane leaves were supplied for the growth and development of the parasitised nymphs. The food was changed twice a day. The adult parasites were kept alive by giving them fresh cut raisins and freshly collected 'honey dew'. The entire rearing of the parasite was carried out in a constant temperatured room running a temperature of 27°C. ±1°C. and a relative humidity of 70%±5.

1. BEHAVIOUR AND GENERAL HABITS OF THE PARASITE

Of the two species of Dryinids that we see in the field as a parasite on the nymphs of *Pyrilla* sp., the more important of the two *Lestodryinus pyrillae* Kieff. is seen in the sugarcane fields from August onwards till the end of December in large numbers. Even a casual examination of the undersurface of the sugarcane leaves will reveal many pupae of the parasite, especially near the mid-rib, sometimes with the shrivelled skin of the host from which the full-fed parasite grub emerged before pupation. It is from these pupae, that the adult Dryinids emerge.

The forelegs of the female adult parasite are abnormally lengthened. The females when resting, place their legs in a characteristic position. The knee joints on either side rise high above the pronotum and are often brought together so as to form a complete angular arch over the thorax. While walking the abnormally developed chelate claw is always folded backwards on the fifth modified joint of the tarsus. The chelate claw is not used except for raptorial purposes. *Lestodryinus pyrillae* is a specific parasite on the nymphs of *Pyrilla* sp. and no alternate host has been recorded so far.

The most remarkable structure in the parasite is the raptorial front tarsi of the female. The tarsus consists of the usual five joints of which the last is abnormally long and modified and together with one of the claws which is also extraordinarily developed forms a seizing and holding apparatus, somewhat similar to that of a scorpion's 'chelate claw'. The great chelate claw is always folded backwards on the modified last tarsal segment and is only extended when it is in the act of seizing its host. Marked sexual dimorphism is seen in the parasite, the males being much smaller and in addition devoid of the chelate claw of the forelegs.

2. HOST SELECTION

The mated females were given different instars of the *Pyrilla* nymphs for oviposition. After a number of experiments and careful observations for hours, it was found that the females exhibited a definite preference for the second, third, and fourth instar nymph for oviposition. It was also observed during the course of these investigations that the first instar nymph was too small and delicate to be handled by the parasite and the final instar nymph was far too strong for the parasite to hold it in its grip and oviposit. It was invariably seen that whenever a first instar nymph was attacked it never recovered from the effect of parasitisation and died after some time. It was also very common to see that the final instar nymph invariably kicked off the parasite every time it approached. As a rule the parasite does not oviposit on nymphs which are already parasitised.

3. Mode of Oviposition

The female parasite, when it is conscious of the presence of a suitable stage of host nymph, approaches it in a crouching manner and comes to a standstill at about a little distance from the host. The whole act resembles that of a carnivorous animal waiting for an opportunity to pounce on its prey. The parasite then waits for an opportune moment to catch the host nymph. The female always tries to get at the host nymph from one side, but whenever the host is aware of its parasite it usually lures its two anal processes vertically and turns back. Evidently this is its only way of protection from the parasite. It will not be out of place here to mention a few observations about the two anal processes of the *Pyrilla* nymph. The writer always found that whenever the soft skin of the body came in contact with the anal tuft of the insect he felt a burning sensation. It was observed that the parasite when attacked by the nymph in its struggle to escape from the clutches of the parasite, usually receives the anal tuft on its eyes. It is possible that the eyes of the parasite are very much irritated by the contact of the anal tuft and hence the parasite runs away from the host. The parasite catches the nymph by a very rapid movement of the front tarsi. The host nymph is then lifted up bodily by means of the two strong modified forelegs and the parasite often bending its body round the vertical side of the host introduces its ovipositor at the base, in between the first and the second wing pads, and oviposits its eggs.

4. Development of the Parasite

Immediately after the oviposition is over the nymph is released by the parasite. However, the nymph lies paralyzed for a few minutes from the effects of parasitisation, but recovers and resumes its normal behaviour. After 5 to 20 days of oviposition the parasitized nymph develops a bag-like structure which protrudes out on its back in between the wing-pads. This bag-like structure is called the 'thylacium'. The thylacium is pale yellow in colour in its early stages of development and it becomes dark yellow in colour after about 15 days. The parasitic grub which is feeding and developing is housed in this bag-like structure. The thylacium is probably a proliferation of the integument of the host and it shields the parasitic larva that feeds on the vital body juice and tissues of the host.

The grub moults in the thylacium and the sections of the thylacium show the moulted skins of the grub arranged in circular rings. 12 to

30 days after oviposition the highly enlarged thylacium bursts open and the fully developed parasitic grub crawls out. The thylacium slits in antero-posterior direction and the middle part of the parasitic grub bulges out slowly. In due course the head and the anal segments are extricated from the thylacium and the freed grub falls out of the host on to the same leaf. The whole process of slitting the thylacium and crawling out from the host takes about 30 minutes. Immediately after the emergence of the parasite grub the host nymph dies.

5. THE LARVA

The grub when it comes out of the host has a brownish yellow head and pinkish coloured thoracic and abdominal segments. The grubs crawl out from the host remains and immediately start spinning a cocoon.

6. THE PUPA

After crawling away from the host remains the grub takes a few minutes' rest and starts spinning a cocoon. Usually the grub completes spinning the cocoon within 24 hours. It then again takes rest for a day or two depending on the temperature and humidity conditions and starts spinning the inner cocoon. The grubs that were kept under controlled conditions always pupated earlier than the grubs that were kept under room temperature during December-January 1952. Normally the female cocoons are double the size of the male cocoon. The female cocoons (outer cocoon) measured 10 mm. long and 3 mm. broad as compared to the male cocoons 5.1 mm. length and 1.9 mm. breadth. The adults emerged from the cocoons 20 to 30 days after pupation under controlled conditions in December-January 1952.

7. SEX-RATIO AND LONGEVITY

Under laboratory conditions the sex-ratio results in excess of males. But under field conditions sample collection of pupae several times showed that the sex-ratio is almost 1 : 1. Under laboratory conditions when the females were fed with sugar solution and 'honey dew' they lived up to 20-30 days. However, under field conditions in the presence of host it is quite probable that they live up to 40-50 days.

8. FECUNDITY

Fecundity studies on this parasite are rather difficult, because the parasites refuse to oviposit as freely as they do in the field in spite of providing suitable stages of the host nymphs. However, the greatest number of ovipositions under laboratory conditions made by a single female in a day was eight. The same female which lived up to 38 days laid 40 eggs. It was also observed that if the female parasite after mating is not provided with suitable hosts for the first few days, it loses much of its interest in oviposition. Perhaps the desire and the ability to reproduce decline if circumstances force the parasite to retain its eggs at a time when its reproductive activity is at its height. However, taking into consideration the development of the ovary at the time of dissection of different ages of parasite, and considering the long life of this parasite under field conditions, it can be fairly estimated that the females are capable of laying from anything between 80-100 eggs during their life-cycle.

9. Feeding Habits of the Adult Females

The adult parasites were fed with 10% sugar solution, freshly cut raisins, and 'honey dew' collected from the field. The females showed a definite preference for 'honey dew' secreted by *Pyrilla* nymph. The females when kept under starvation, or when not fed with 'honey dew', showed predatory habits. As soon as the nymphs were introduced into the tubes in which the starved females were kept, the females immediately seized the nymph and started sucking the body juice from the thoracic or from the abdominal region of the nymph. The females that were fed with 'honey dew' regularly did not show any inclination towards predatism. Perkins (1905) is of the opinion that when a Dryinid female is kept under unnatural conditions and under the pressure of hunger, the hopper nymphs are killed outright and to a certain extent devoured. These studies suggest a more definite cause of predatism. Females raised on raisin and sugar solution fed on the body juices of the nymphs, while those fed on 'honey dew' showed no inclination towards predatism. The nitrogenous material which is so essential for the development of the eggs in the ovaries is easily available in the 'honey dew' secreted by the *Pyrilla* nymphs. This suggests that the real cause of predatism is the lack of nitrogenous food material.

10. Parthenogenesis

It is very common to find females, after the pre-oviposition period is over, trying to parasitize nymphs even though they are not mated. Under such circumstances the progeny will consist of males only.

11. Hibernation

Normally, pupae collected in the field during the cold months of December and January are under hibernation, and even when they are kept in the temperature controlled room they fail to emerge within a short time. During March and April, the parasitic grubs hardly take 3 to 4 days to pupate, after spinning the double cocoon, though during winter they may take as many as 100 days to pupate after spinning the cocoons. There is no doubt that this is the only way to overcome the winter months and become active once again during warmer months. As yet, no alternative host is recorded for this parasite. It seems imperative that the parasite should hibernate and wait for the activities of its host *Pyrilla* to begin.

12. Effect of Parasitisation on the Host

The young *Pyrilla* nymphs after their release from the chelate claws of the female Dryinid remain paralyzed for about 3-5 minutes, but soon recover their normal activities of hopping from place to place and sucking the sap from the leaf. The parasitized nymphs continue to be active except that they do not moult, indicating that an arrest of growth is taking place. The healthy nymphs of the same instar when kept for observation as controls, moulted regularly, completed their nymphal stage, and became adults.

13. MULTIPARASITISM

Multiparasitism was often seen on this pest when field collected nymphs that did not show any external symptoms of parasitization by the Strepsipteran, *Pyrilloxenus compactus* Pierce, were accepted by the Dryinid parasites in the laboratory for oviposition. After a few days development of both the parasites was found on the same host. But the growth of the Strepsipteran was completely arrested by the Dryinid grub and when the fully developed grub emerged out of the thylacium, it killed the host as well as the incompletely developed Strepsipteran.

14. HYPERPARASITE

During the long hibernation of the Dryinid in the cold months of December and January, it is subjected to parasitization by a chalcid wasp *Cristatithorax quadricolor* Gir. belonging to the family Encyrtidae. The Dryinids are attacked in their prepupal stage. However, the percentage of hyperparasitism was so negligible during the 1951-52 seasons that one need not lay much emphasis on this hyperparasite. Out of the 300 pupae that were collected from the field only four were hyperparasitized. But it is an important aspect of the study of insect parasitism to an economic entomologist, because it is very difficult to tell when these seemingly unimportant insects would assume such proportions as to completely neutralize the beneficial work of the primary parasite.

The hyperparasites that emerged from the field-collected Dryinid pupae were given prepupal stages of *Lestodryinus* for parasitization. It was observed that the parasites always oviposited from the sides of the cocoon but never from the top of the cocoon. This is probably due to a large intervening space between the cocoon and the prepupa or to the toughness of the cocoon at the top. The dissected hyperparasitized pupa showed that the hyperparasite grubs had eaten up all the host body except the chitinous head portion. After the grubs are fully fed and developed, and just before they pupate, they excrete a large amount of faecal matter. The faecal matter is passed out in pellets and is excreted in one direction. All the larvae that develop in one cocoon arrange their heads in one direction so that the faecal matter is deposited in the opposite direction. They pupate naked. Only one exit hole is cut through and all the hyperparasites come out of this common hole. The entire life-cycle of the hyperparasite occupies from 13-15 days under controlled conditions. From a female Dryinid pupa normally 6-7 hyperparasites and about 3 parasites from the male pupa emerge. The sex-ratio is cent per cent female. During the course of these investigations the writer has not recorded any male hyperparasite. It is evident that the hyperparasite is capable of reproducing by 'dueterotokous' type of parthenogenesis.

15. THE ROLE OF DRYINID PARASITE IN KEEPING DOWN THE POPULATION OF *PYRILLA* IN THE SUGARCANE FIELDS

The vital role played by the Dryinid parasite *Lestodryinus pyrillae* and *Chlorodryinus pallidus*, especially the former, in keeping down *Pyrilla* pest in the sugarcane fields is not sufficiently realised by economic entomologists. The population of *Lestodryinus* is far greater, and observations for about 5 years have shown that in Delhi *Chlorodryinus* is almost absent, though this species is found in small numbers in the Indian Agricultural Research Institute's Sub-Station at Karnal and the Sugarcane Research Station at Pusa, Bihar. So the importance of *Lestodryinus pyrillae* need hardly be emphasised.

For a proper appreciation of the role played by *L. pyrillae* we have to make a passing survey of the interaction of the other parasites with the host, in this case *Pyrilla*, from the time it makes its appearance in the field. Though sugarcane is planted in February and the cane begins to germinate in 2 or 3 weeks later and would have grown to 6″ to 9″ high by the 3rd or last week of March, *Pyrilla* are not seen in large numbers till the first monsoon showers fall on the parched earth. Sometimes one or two heavy summer showers may make the climatic conditions conducive to the growth and multiplication of these pests. But when these showers are followed by dry hot weather accompanied by hot northern winds of the deserts, the population of *Pyrilla* again dwindles. If, however, there is a ratoon crop growing near the planted crop there may be a small *Pyrilla* population. But even then they tend to disappear in the scorching heat, which is a distinct climatic factor of the northern plains where the major portion of India's sugarcane growing area lies. So then, when the monsoon showers fall, with the simultaneous fall in in the temperature *Pyrilla* begins to multiply. At this stage the egg parasites appear in the field and the first to appear is *Tetrastichus pyrillae* Craw. Soon others follow. They are *Ageniaspis pyrillae* and *Cheiloneurus pyrillae.* The fourth egg parasite *Ooencertus paplionus* is not seen in Delhi, though it is recorded at Karnal and at Pusa, Bihar. But the climatic condition is so favourable for an increase in host population that *Pyrilla* begins to multiply faster than the egg parasites. It is at this stage that *Lestodryinus* plays its great role. At this time of the year when the sugarcane field is carefully examined we will find thousands of nymphs sucking the sap of the sugarcane leaves on the dorsal side of the leaves. Mostly near the mid-rib or sometimes but rarely dispersed away from the mid-rib are seen a very large number of pupae of *Lestodryinus pyrillae.* Thousands of nymphs of *Pyrilla* have been parasitised by this Dryinid parasite and the full fed larvae have come out of the body to pupate on the sugarcane leaves. Dryinid parasite appears in the field to parasitise the nymphal stages while the egg stage is parasitised by the Chalcid wasps referred to above. There can be no doubt that the *Pyrilla* problem could have been far more different than what it is today, but for the great role played by these parasites that appear in sequence when the host has passed from the egg stage to the nymphal stage. When the nymphs have further developed into adults the later are stylopised by *Pyrilloxenes compactus* (Strepsiptera). In biological control, in the case of hosts that have a high degree of prolificacy, a sequence or a chain of parasites parasitising each stage in the growth and development of the pest to keep down the host population is necessary. *Pyrilla* offers a good example where the sequence theory of the biological control of insect pests is exemplified to the fullest extent. We can easily imagine what would have been the state of *Pyrilla* infestation if, with its overlapping broods, it got freedom to multiply in geometrical progression.

The application of sequence theory in the biological control of insect pests was first enunciated by Fiske and its practical importance has been stressed by Howard (1924). Though this theory may mainly apply to the control of Lepidopterous pests whose component stages in the life-cycle differ in activity, habit, seasonal appearance, and other factors, it is certainly of advantage in other serious pests that have a terrific rate of reproduction. Under such conditions species of pests are almost invariably attacked by a succession of different parasites affecting the eggs, larvae, and pupae respectively. The sequence theory maintains that sometimes more than one parasite or predator is necessary to subjugate a major pest. This theory also suggests that it is only when a certain percentage of the eggs have been destroyed that the parasites of the larvae will be able to reduce a given pest to a degree sufficient for the final pupal parasites to bring the species measurably under control. Fiske, the originator of the sequence theory, has calculated that a total parasitism of 88.33 per cent is necessary in order to attain effective control in the case of the gypsy moth.

Here, for instance, is an example of a hemipterous insect pest that has an enormous rate of reproduction and where a sequence of parasites attack the various stages in its life-cycle, gradually increasing the percentage of parasitism from 60% to 85% by the time the host completes two or three generations. In Delhi, sometimes 15% to 20% of the *Pyrilla* nymphs are parasitised by the Dryinid in the field. This is certainly a high degree of parasitisation closely following sometimes 60% to 70% parasitisation of the host eggs by the Chalcid parasites. In any biological control venture the best results are always obtained by a sequence of parasites attacking different stages of host, and *Pyrilla* offers one of the outstanding examples in the Indian sub-Continent where a number of parasites attack the pest in its different stages of growth and development and keep down the population to a manageable extent in the field.

One word of warning should be uttered at this stage. Throughout India within recent years it has become a fashion to use indiscriminately the recently discovered organic insecticides to keep down the population of the pest. These insecticides not only kill the pest but also its parasites. Thus the balance in nature of the parasitic population is destroyed with the result that *Pyrilla* epidemic that used to be seen in the fields now and then has now become a regular feature in the sugarcane growing tracts of our country. This is a most unfortunate development and the need for judicious use of these insecticides in capable and well trained hands need hardly be emphasised.

SUMMARY

The biology and bionomics of *Lestodryinus pyrillae* Kieffer a nymphal parasite of *Pyrilla perpusilla* Walk. has been studied.

The mated female selects only 2nd, 3rd, or 4th instar nymphs for oviposition. The parasite grubs develop in a bag-like structure known as thylacium which appears in between the wing pads. The development of the parasite from egg stage to the emergence of the adult occupies 25 to 40 days under controlled conditions. During the period of growth and development the parasitic grubs feed on the host's body fluid and finally attack the vital organs. Under field conditions the sex ratio is almost equal. However, males predominate under laboratory rearing. The females live up to 30 days. The females when deprived of 'honey dew' and given accession to nymphs predate upon them. The parasite hybernates in prepupal stage during winter months. No alternative host is recorded for the parasite. Multiparasitism exists between *Lestodryinus pyrillae* and *Pyrilloxenus compactus* Pierce. However, *Pyrilloxenus* succumbs to the effect of multiparasitism and *Lestodryinus* successfully completes its life-cycle.

A hyperparasite namely *Cristatithorax quadricolor* Gir. has been reared from the pupae of *Lestodryinus* and its biology has been studied. The role of dryinid parasite in keeping down the population of *Pyrilla* in the sugarcane fields has been discussed.

ACKNOWLEDGEMENTS

I am grateful to Dr. E. S. Narayanan, M.A., Ph.D. (Lond.), D.I.C., Head of the Division of Entomology for suggesting the problem and for guidance and encouragement throughout. My grateful thanks to Dr. B. P. Pal, Director, Indian Agricultural Research Institute, for his keen interest in this piece of research.

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REVIEWS

1. ANIMALS OF THE RUHUNA NATIONAL PARK. By C. E. Norris, F.Z.S. Pp. vii+45 ($8\frac{3}{8}'' \times 5\frac{3}{8}''$). 20 full page drawings. Colombo 1956, The Associated Newspapers of Ceylon. Price, Popular Ed. Rs. 2.25, Library Ed. Rs. 3.50.

This is an excellent little handbook covering 20 species of animals and reptiles found in the Ruhuna National Park in Ceylon.

The publishers rightly state: 'The author describes in clear and precise language twenty kinds of animals likely to be seen in the Ruhuna National Park, giving their scientific and popular names, the habits of each kind, and the parts of the Park in which each is found.' The illustrations, with a few exceptions, are well done.

The price which is not marked on the book unfortunately appears to be on the high side and, while the cost of production is doubtless high, it is necessary that such publications be offered at prices which the average visitor to the national park would not mind paying. If necessary, this should be done by Government subsidy.

In the introduction the author offers some hints to visitors to national parks, and it is interesting to note that gramophones are prohibited therein! In the peoples' parks on the outskirts of Bombay city it is a common experience that many visitors are far more interested in picnicking and in their gramophones and other loud-noise-making apparatus than in the natural history of their surroundings. Although this form of jollity has fortunately not yet spread to our national parks which contain any wild life worth the name, good guide books of the type reviewed, with statutory 'dos' and 'don'ts' of a general nature as well as relating to the special circumstances of each individual park, would be of great help to visitors.

H.A.

2. LIVING WITH BIRDS. By Len Howard. 256 pages ($7\frac{3}{4}'' \times 5\frac{1}{4}''$). 24 plates and 6 line drawings. Collins, London, 1956. Price 15*s*.

The authoress has been living for fourteen years in Sussex with wild birds freely flying in and out of her little cottage. As human visitors disturb the birds, they are discouraged and, on the rare occasions when they are admitted, come on strict terms—they must approach and depart by a particular route, they must not make sudden noises or sudden movements, and their stay must be confined to certain hours.

Miss Howard's—I apologise if I have made a mistake as to her status, but the existence of a husband does not seem reconcilable with the time and devotion which she gives to her birds—principal tenants are Great Tits, whose genealogies she sets out to the third and fourth generation. Her relations with them are intimate and strange birds approach her readily, usually when she is in the company of birds that know her but also, at times, when she is alone and away from her cottage.

Miss Howard must have a reputation among birds as a doctor and a nurse, for injured birds, some of them apparently strangers, come to her frequently for treatment and care. But it is as a child's nurse that she excels. Some of the Great Tit parents make it a practice to hand over their fledglings to her, as to a finishing school, before the little ones become entirely independent. Many of these are babies which have been reared outside her garden. At such times Miss Howard is kept busy from early morning to late evening finding suitable food for her charges, who are fussy about their food and have their individual preferences.

Having lived so long with her birds, Miss Howard has much to tell that is interesting. What I found most engrossing, however, was her account of the mathematical genius Star. 'One morning, the 6th January, the idea struck me of trying her with a counting experiment. When, as usual, she flew to my hand for her nut, instead of giving it to her I held it up in my other hand and said, "You must tap for it". Looking at her intently I called in sharp accents, "TAP, TAP". While I spoke her eyes were fixed keenly on mine, then she immediately flew to the top of a wooden screen-frame—a favourite bird perch—and deliberately rapped out two taps on the wood with her beak, copying my speed, she then flew to my hand for the nut. An hour later I tried her again with the same number. She responded correctly in exactly the same manner, flying to my hand directly afterwards for her nut. She had never been given food for hammering at things, on the contrary, as already related, I had tried to stop her indiscriminate hammerings in the autumn.' Lessons continued with breaks for nest-building and the rearing of families, till Star learnt to respond up to eight raps, and later to comply correctly with verbal directions asking for any number up to eight raps. This was not all; she even showed a knowledge of addition, by breaking up the bigger numbers into different groups of smaller numbers.

This is a fascinating book which I confidently recommend to all lovers of Nature.

D.E.R.

3. AUDUBON WESTERN BIRD GUIDE: LAND, WATER AND GAME BIRDS. By Richard H. Pough. Pp. xxxvi+316 ($7\frac{1}{4}'' \times 4\frac{1}{2}''$). 340 full-colour illustrations by Don Eckelberry and 138 black and white drawings by Terry M. Shortt. Doubleday and Company, Inc. New York, 1957. Price ?

This book, the third in the author's series of Audubon bird books, relates to a region measuring about two and a half million square miles and comprising western North America from the Arctic Ocean to the Mexican border, and the oceans to the west and the north. Local conditions vary widely in this area, and 614 different species of birds are covered.

The book is a model of economy of words and space. 411 species were previously described in the earlier books. New information about them is generally confined to their range and certain body dimensions. Detailed information is given about the other 203 species in brief, precise, and pointed terms, emphasising clearly the main distinguishing features, which are indicated with equal clarity in the illustrations. Considerable saving of space is effected by the judicious use of abbreviations, and the lay-out artists are to be congratulated on the skill with which they have compressed the coloured illustrations of 219 species into 32 plates without sacrificing clarity; there are besides this 138 black and white drawings contained in 282 pages of text.

It is interesting, among the species described, to come across some familiar names. The White Wagtail (*Motacilla alba*) and the Yellow Wagtail (*Motacilla flava*) occur naturally in this region. The Chukor (*Alectoris graeca*) introduced from 1893 onwards has established itself in the Great Basin from Colorado to California and Oregon to New Mexico. Other introductions are the Spotted Dove (*Streptopelia chinensis*), which is to be found in cities and towns through most of South California, and the Ring Dove (*Streptopelia risoria*), which is not as successful a settler in its new home.

The book is tastefully got up and of a handy size. Ready reference has been provided for by cross-references between the illustrations and the text in the book itself and between the book and the earlier books in the series.

D.E.R.

4. THE AMPHIBIA OF CEYLON. By P. Kirtisinghe. Pp. xii + 112 ($8\frac{1}{3}'' \times 5\frac{3}{4}''$), 1 plate (coloured frontispiece) and 74 text-figures. Published by the author, 2 Charles Circus, Colombo 3, Ceylon, and printed at William Clowes and Sons, Limited, London and Beccles, 1957. Price Rs. 14.50.

The study of the fauna of an insular area is always a fascinating subject, especially so when it pertains to a small but interesting group of animals such as amphibia. Until the present publication, no comprehensive treatise on the amphibia of the Indian region more recent than the work of Boulenger (*Fauna of British India*, 1890) was published, and hence, although regional, this book partly helps in filling a gap. Mr. Kirtisinghe has been studying the amphibia of Ceylon for several years and has now brought together in book form a considerable amount of information scattered through literature with many personal observations to make it a very useful reference work and field guide.

The amphibian fauna of the Island is closely related to that of the Indian sub-continent. It has species that are widely distributed, such as *Bufo melanostictus* Schneider, *Rana cyanophlyctis* Schneider, etc., and at the same time an endemic genus *Nanophrys* Günther. The limbless and blind or nearly blind Caeciliidae have their representatives on the Island. Far more interesting is the occurrence of a highly specialised species, *Rhacophorus microtympanum* (Günther), with a direct development on land as was first described by the author in 1946.

The whole subject is rather attractively introduced with a résumè of the earlier work on the amphibia of the Island, and on this basis the author has attempted a codification of the nomenclature—a very logical approach. This has no doubt enabled him to give a correct rendering of the names as far as possible. The nomenclatorial discussions on pages 8-13 will undoubtedly interest specialists working on the amphibia of south-east Asia. The descriptions and drawings of tadpoles of *Rana corrugata*, *R. limnocharis greeni*, *R.* (*Hyalorana*) *temporalis*, *Rhacophorus c. cruciger*, *Rh. cruciger eques*, and *Microhyla zelyanica*, given for the first time, add to the value of the book as a reference work.

The synopsis for the identification of the families, genera, and species, and those given for the tadpoles, are concise and easy to follow, although on pages 14 and 15 they are given in three different styles. The taxonomic descriptions of the species are exhaustive and each species is well illustrated. As the author has pointed out, the synonyms cited under each species primarily refer to records from Ceylon.

A few minor criticisms are called for. The inclusion of a topographical map of Ceylon marking the localities of collection would have given the reader a better idea of the distribution of these animals, both in the upcountry and the lowcountry and in the different watersheds of the Island. Another drawback is the almost complete absence of ecological data for the species, which otherwise would have been a helpful guide to the amateur naturalists as well as to the specialist. The reviewer cannot agree with the author that the endemism seen among the Ceylonese amphibia is mostly the result of independent evolution within the group on the Island during the last ten to fifteen thousand years. Although both geographical and biological isolations are involved, the fact that about 42.4 per cent of the amphibian fauna should evolve within such a short time on the Island is an incredibly fast rate of speciation! Until such time as the amphibian fauna of India, especially of peninsular India and Ceylon, are studied in greater detail, it seems premature to attempt any speculation on the dates.

These few points should not, however, detract from the value of a book which is bound to remain a standard work of reference on Ceylonese amphibia for many years. The author is to be congratulated for bringing out such a scholarly work, and credit also goes to the printers for the high standard of production. This book will undoubtedly stimulate more interest both in the amateur naturalists and the 'specialists' interested in these slimy creatures, the study of which has hitherto not received its due share of recognition in this country.

E.G.S.

5. BRITISH TREES: A GUIDE FOR EVERYMAN. By Miles Hadfield. Pp. xxv + 468 ($8\frac{1}{4}'' \times 5\frac{1}{4}''$), including 150 pages of line drawings. J. M. Dent and Sons Ltd., London, 1957. Price 30*s.* net.

This book is intended to help 'Everyman', that is to say the man with no special scientific knowledge, to recognise the trees, both native and introduced, that he is likely to encounter in Britain. The author has two 'negative' but real qualifications for the task, he is neither a trained botanist nor a forester. Having taught himself and acquired his knowledge the hard way, he appreciates the difficulties of the layman and does not overwhelm his reader with scientific terms. It is impossible to avoid technical terms altogether, but they are reduced to a minimum and, where they occur, are explained in simple language where they are used or in an appendix at the end of the book.

Identification is made easy by the numerous drawings illustrating the roots, shoots, buds, leaves, flowers, fruits, seeds, and other parts. These are the work of the author himself, and show an attention to detail which is rare in this age of hurry and progress. Only an artist in love with his task could turn out work of this quality. We wish that he had completed his task by giving his readers an idea of the tree as a whole. To most of us who love trees it is the tree itself that matters, and the details illustrated are important only for the purpose of identification or as contributing to the appearance of the tree as a whole. The author has given us a tantalising glimpse of his capacity in this respect in his illustration at page 57 of the typical forms of the Atlas cedar and the Lebanon cedar.

An excellent book, which makes us wish that someone will be inspired to do something similar for us in India.

D.E.R.

6. NO PASSPORT TO TIBET. By Lt.-Col. F. M. Bailey. Pp. 294 ($8\frac{3}{4}'' \times 5\frac{3}{4}''$) Rupert Hart-Davis, London, 1957. 25*s*.

This book, reconstructed from the author's diaries, is a clear and breezy account of a journey through unsurveyed and largely unknown country. In 1913, when it was made, the upper course of the Tsangpo through eastern Tibet was unknown, and the author was keen to verify Kintup's report of 150-foot 'Rainbow' falls. He made one attempt to approach from the Chinese side, and follow the river down into Assam, but had to abandon it because the Chinese and Tibetans were fighting in the crucial area (called Po me). This journey has already been described in another book, *China-Tibet-Assam*. He had acquired a good knowledge of Tibetan from his three and a half years as trade agent in Gyantse and Chumbi, he knew and had photographs of the Dalai and Tashi Lamas, and he managed to get himself attached as Intelligence Officer to a mission sent in 1913 to the Chulikatta Mishmi country in northern Assam. Then, with Captain Morshead of the Royal Engineers to act as surveyor, Captain Bailey set off with two objectives. First to follow the course of the Tsangpo between the point where it was known to disappear into the tangled mountains of eastern Tibet at an elevation of about 10,000 ft. to where it debouched into the plains of Assam at about 500 ft.; second to map the geographical frontier between Tibet and Assam. The semi-independent rulers of the villages of southern Tibet were in a state of sporadic war with the Abors and Mishmis of Assam, and trading was often combined with raiding. Though Captain Bailey had no authority from the Government of India he was able to convince the officials of the areas through which he passed that he was doing useful work in demarcating the territories of each authority, and therefore to get transport and supplies for his party. Both main objectives were attained.

Apart from the political difficulties which had to be overcome, the journey could only have been performed by men of remarkable stamina. During the months of August, September, and October they covered over a thousand miles, usually at an elevation of over 10,000 ft. and crossing at least four passes over 17,000 ft. They started out with ten coolies (seven Tibetans, two Gurkhas and a Lepcha cook), and must have had a fair amount of surveying equipment and collecting boxes. For shelter they had a forty-pound tent, and they relied on local supplies for food. Their money was stolen about half-way, but a Kashmiri merchant came to their rescue and advanced them Rs. 250 with which they were able to manage till they reached the rail-head at Rangiya, 30 miles north of Gauhati. The highest recorded collecting was done at the end of August at over 16,000 ft., where Red Apollos (*Parnassius epaphus sikkimensis*) were plentiful.

During the expedition Colonel Bailey made a collection of about two thousand specimens of butterflies belonging to two hundred different species, of which a detailed account has been given in the *Journal* by Colonel W. H. Evans (Vol. XXIII, pp. 532-46).

How they managed to transport their specimens over 1,500 miles of Tibetan tracks is not explained—this, like the daily miracle of securing coolies and ponies, often from reluctant headmen, is passed over with what Bailey in another connexion calls 'characteristic British understatement'. They brought back several new mammals, however, including a goral, a rat (*Epimys brahma*), and a shrew (*Soriculus baileyi*). They found the so-called Sikkim stag (*Cervus affinis*). They identified the habitat of the Eared Pheasant (*Crossoptilon harmani*), and collected a chick in the Tsangpo Gorges, and were told that its plumage was blue because it fed on aconite! The chick and adult specimens collected later are figured on p. 332 of Stuart-Baker's *Game Birds*. Among the flowers seen in bloom at about 11,000 ft. on 10 July was the blue poppy of which Kingdon Ward collected the seeds in 1924, and which is now well-known as *Meconopsis baileyi*. But (to quote the author) 'quite as important as the discovery of new specimens was the observation of the fauna and flora characteristic of the different places through which we passed'.

The maps, which are so important in a book of this kind, are excellent. They are drawn by K. C. Jordan and are presumably based on Morshead's surveys. The whole route is covered in a series of hachured maps, with the author's route marked, and the rivers, villages, and main physical features named, together with heights, usually obtained by measuring the temperature at which water boiled. The scale at which these are reproduced is usually about 16 miles to the inch, though the Tsangpo Gorge area is mapped at 10 miles and the Bhutan-Assam section at 30 miles. The spellings in text and maps are nearly always in agreement.

The photographs are disappointing, but this is not surprising as they were taken in 1913 and (presumably) developed many months after exposure. They all relate to the early part of the route, as Bailey lost his camera soon after leaving the Rainbow Falls.

After reading this account of men who made their way from one dangerous area to another, very lightly armed and carrying a considerable sum of money, it is no surprise to find the author confessing that he is an 'optimist of human nature'. Men in his experience are fools not knaves. 'The people of Gyala warned us against the people of Po me, who were unscrupulous and unreliable, bad people, unlike the people of Kangbo. In Po me we had received the same warnings against the people of Kangbo. It seems to be universal, the inability of human beings to feel virtuous except when surrounded on all sides by rogues and villains.' So, although the frontier agreement with China, which Morshead's survey made possible, was repudiated by Peking, one feels the author has good ground for his belief that 'the next hundred years may make the Chinese Communist way of life as humane as that of Tibet'.

R.E.H.

7. NATURAL HISTORY OF BIRDS: A Guide to Ornithology. By Leonard W. Wing. Pp. vi+539 (9″×6″). 222 illustrations (text figures, diagrams, maps, graphs). The Ronald Press Co., New York, 1956. Price $6.75.

An up-to-date and authoritative guide to ornithology for university students, and for bird-lovers whose interest does not end at mere loving, was urgently needed. For a time Elliot Coue's FIELD AND GENERAL ORNITHOLOGY and then Thomson's BIOLOGY OF BIRDS had filled the bill admirably, and indeed their usefulness in their respective ways remains largely undiminished even today. But scientific ornithology has in the meantime advanced by leaps and bounds, and struck out in such divers and undreamt of directions—with incursions into physics, chemistry, statistics, mathematics, astronomy, and practically every other branch of science—that something more comprehensive was called for.

For the serious 'amateur' who has not the time or the facilities for keeping himself in touch with ornithological progress through the rising spate of periodical literature, and who is yet desirous of remaining well informed, such a book, and *just* such a book, was badly wanted; and it will doubtless be enthusiastically welcomed. It covers every aspect of bird life, with refreshing emphasis on the *living* bird and its ecology. Though understandably somewhat American in bias as regards the examples cited—it is obviously intended for American students primarily—the book is so well and readably written that users in other parts of the world will find it equally instructive and interesting.

The last 5 of its 24 chapters are of wider and very special interest. They cover 'Heredity in the Bird' (inherited characters, mutations, geographical and ecological variations, importance of birds in genetic studies, etc.); 'Health in Wild Birds' (parasites, viruses, birds as disease reservoirs, etc.); 'Rise of Bird Protection' (historical development, plumage trade, international treaties, protection of bird colonies, extinction, rare and threatened (American) species, attracting birds, feeding trays, nest boxes, etc.); 'Economic Relations of Birds' (food habits, ecological-economic relations, domestic use, etc.). The final chapter entitled 'Bird Study Afield' furnishes practical suggestions about the kinds of studies that may be profitably carried out, methods, field techniques, equipment, etc.

At the end of every chapter is given a list of 'Suggested Reading' for the benefit of those who would delve deeper into the subjects treated.

A very full list of bibliographical references is contained in Appendix I, while Appendix II, 'Bird Orders and Families of the World', will serve as a sheet anchor (howsoever ephemeral) to the bewildered ornithologist floundering in the turbulent sea of ornithological taxonomy and praying fervently that, for better or for worse, the classification of Wetmore (here followed) may be spared at least during his own mortal span!

A complete glossary of relevant scientific terms concludes this very timely and useful book which I consider quite indispensable not only for the intelligent bird-lover as a guide to ornithology but also for the intelligent ornithologist as a guide to bird loving!

S.A.

8. THE ORNITHOLOGISTS' GUIDE: Especially for Overseas. Edited by Major-General H. P. W. Hutson, C.B., D.S.O., O.B.E., M.C. Pp. xix + 287 (8½" × 5½"). Text figures and diagrams. British Ornithologists' Union, London, 1956. Price 21*s*.

It was a happy thought on the part of the Committee of the British Ornithologists' Union to produce this compendium chiefly for the benefit of their members and others interested in bird study who, by accident or design, live in 'exile' in distant corners of the earth, cut off from the stimulating influence of ornithological libraries and fellow-ornithologists, and from current ornithological thought and trends.

Its main object is to encourage such 'exiles' and show them the possibilities of any ornithological work that may lie at their doorstep unbeknown, and to harness their opportunities for useful contributions to the ornithology of the remote and little known areas where their lot may be cast. It is a collection of short informative articles specially written by a number of leading British ornithologists on a great many topics of modern bird study, surveying the general state of our knowledge and indicating how it may be furthered, suggesting profitable avenues for field work within the competence of an averagely keen 'amateur', describing the methods and techniques in vogue, and giving useful hints.

The book is divided into the following sections: General; Geographical Aspects; General Behaviour; Breeding; Protection; Study Techniques; Some Suggestions for Special Study; Regional Information; General Information. Most of these sections are made up of a number of succinct articles, which between them give a good overall picture of the achievements and trends of modern ornithology and indicate the important role of the field ornithologist in advancing scientific knowledge. The Regional Information contained in Section VII mostly concerns areas of the Old World where any ornithological work is being done. It includes the West Indies and Latin America but omits North America, presumably because relevant information concerning it is readily available. It gives the names and addresses of individual ornithologists and societies in the different areas who may be contacted for local information, and also the titles of some standard reference books on the birds there.

Altogether a very praiseworthy compilation which should prove of great usefulness not only to the 'exiles' but also to all others interested in the trends of modern bird study. The B.O.U., the Editor, and all the individual contributors deserve congratulation.

S.A.

9. ON THE TRAIL OF VANISHING BIRDS. By Robert Porter Allen. Pp. ?. McGraw-Hill Book Co., Inc., New York, 1957. Price ?.

Since its foundation in 1901 the National Audubon Society has worked for the preservation of American bird life. By the early thirties it was realised that for certain vanishing species bird sanctuaries and protection by law with wardens to enforce it were not sufficient. Rapid development and expanding building and other projects were encroaching upon or disturbing the winter resorts, the feeding grounds, and the nesting areas of the birds, and precise information as to the habits and requirements of the birds was wanted as a basis for measures for their preservation. Mr. Allen, now Research Director of the Society and then a newly recruited member of the Society staff, took part in the research that followed. In this book he tells us something of the manner in which the information was collected, and about the difficulties, hardships, and even danger, which the investigators had to encounter. He deals particularly with the Roseate Spoonbill, the Whooping Crane, and the American Flamingo.

Thanks to the efforts of the Society the number of nesting pairs of the Roseate Spoonbill in the Florida breeding colony has risen from 15 to more than 150, but the author wisely observes that the birds 'are by no means out of the wood'.

The position of the Whooping Crane was, and still is, desperate. The only surviving migratory flock, wintering in Aransas (Texas), numbered 15 individuals in April 1939, and it was an urgent problem to ascertain their migration route and their nesting area, somewhere in Canada, so as to ensure protection for them all the way. A frantic search followed, in which the co-operation of everybody was enlisted, and reports received daily from truck-drivers, air-pilots, garage-mechanics, school-boys, farmers, businessmen, etc. were investigated, more often than not with negative results. The importance of getting such help is shown by the ultimate discovery (in 1954) of the nesting area, which was the result of an observation made by two members of the Canadian Wildlife Service and Forestry personnel engaged in dealing with a forest fire.

An attempt made to breed Whooping Cranes in captivity is the basis of an interesting description of their nesting behaviour. It is to be hoped that, now that their natural nesting area is known, we shall have an account of the nesting behaviour in the wild. In the section dealing with the American Flamingo Mr. Allen tells us about the prenuptial dance of the Flamingo—a riotous communal affair in which the females take an active part. These glimpses of what Mr. Allen can do in this line make us wish that he had told us a little more about what he observed, but perhaps that would have been a digression from the object with which he set out to write the book.

An idea of the extent of the interest and sympathy roused by the efforts of the Society is given by the following incident. A proposal by the United States Air Force to establish a flash-bombing range on Matagonda Island threatened the continuance of the Whooping Crane Refuge at Aransas. The matter was taken up by the Canadian Government and as a result the proposal was abandoned.

In the course of his searches Mr. Allen took part in a hunt for contraband gun-runners, which might have formed the subject of a Gilbert and Sullivan opera. He had other adventures also, which those who are interested may profitably read for themselves.

D.E.R.

ADDITIONS TO THE SOCIETY'S LIBRARY

The following books have been added to the Society's Library since January 1956:

Review copies:

1. BOTANICAL COLLECTOR'S MANUAL. By H. Santapau, S.J., F.N.I. (Ministry of Natural Resources and Scientific Research, New Delhi, 1955).

2. POWAI THE FISHERMAN'S PARADISE: A Practical Handbook for bottom fishing in India. By D. L. Amore (Hind Kitabs Ltd., Bombay, 1956).

3. A COLOURED ATLAS OF SOME VERTEBRATES FROM CEYLON, VOL. III. Serpentoid Reptilia. By P. E. P. Deraniyagala (Ceylon National Museums Publication, December 1955).

4. BIRDS OF CEYLON 3. By W. W. A. Phillips (The Associated Newspapers of Ceylon Ltd., Lake House, Colombo, 1955).

5. THE SHERPA AND THE SNOWMAN. By Charles Stonor (Hollis & Carter, London, 1955).

6. AUDUBON WESTERN BIRD GUIDE: Land, Water and Game Birds. By Richard H. Pough (Doubleday Co. Inc., Garden City, N.Y., 1957).

7. BRITISH TREES: A Guide for Everyman. By Miles Hadfield (J. M. Dent & Sons Ltd., London, 1957).

8. TAXONOMIST'S GLOSSARY OF GENITALIA IN INSECTS. Edited by S. L. Tuxen (Ejnar Munksgaard Ltd., Copenhagen, 1956).

9. ZOOLOGICAL PHOTOGRAPHY IN PRACTICE. By Hugh B. Cott (Fountain Press, London, 1956).

10. THE MOLLUSCA OF KRUSADAI ISLAND (in the Gulf of Manaar). II. Scaphopoda, Pelecypoda and Cephalopoda. By S. Thomas Satyamurti (Bull. of the Madras Govt. Museum, New Series—Natural History Section—Vol. I, No. 2, part 7, 1956).

11. THE AMPHIBIA OF CEYLON. By P. Kirtisinghe (Published by the Author, 2 Charles Circus, Colombo 3, Ceylon, and printed by William Clowes & Sons Ltd., London, 1957).

12. ANIMALS OF THE RUHUNA NATIONAL PARK. By C. E. Norris (The Associated Newspapers of Ceylon Ltd., Lake House, Colombo, Ceylon).

13. NO PASSPORT TO TIBET. By Lt.-Col. F. M. Bailey (Rupert Hart-Davis, Soho Square, London, 1957).

Purchased:

1. MR. GOULD'S TROPICAL BIRDS. Edited by Eva Mannering (The Ariel Press, London, 1955).

2. THE NATURAL REGULATION OF ANIMAL NUMBERS. By David Lack (Clarendon Press, Oxford, 1954).

3. THE FAUNA OF BRITISH INDIA, INCLUDING CEYLON AND BURMA—BUTTERFLIES. Vol. II (Fauna of India, including Pakistan, Ceylon and Burma). By G. Talbot (Taylor & Francis Ltd., Red Lion Court, Fleet Street, London, E.C. 4, December 1947).

4. THE FAUNA OF BRITISH INDIA, INCLUDING CEYLON AND BURMA—BIRDS. Vol. I to Vol. VIII. By E. C. Stuart Baker (Taylor & Francis, Red Lion Court, Fleet Street, London, 1922 to 1930).

5. NO ROOM FOR WILD ANIMALS. By Dr. Bernhard Grzimek. Translated from the German by R. H. Stevens (Thames and Hudson, London, 1956).

6. WILD AMERICA. By Roger Tory Peterson and James Fisher (Collins, St. James's Place, London, 1956).

7. NATURE'S TEACHINGS: Human Invention anticipated by Nature. By the late Rev. J. G. Wood (New and Revised Edition) (William Glaisher, 265 High Holborn, London, 1907).

8. FISHES: Journeys and Migrations. By Louis Roule. Translated from the French by Conrad Elphinstone. (George Routledge & Sons Ltd., Broadway House, 68-74 Carter Lane, London, 1933).

9. NOAH'S CARGO: Some Curious Chapters of Natural History. By George Jennison (A. & C. Black Ltd., 4, 5 & 6 Soho Square, London, W. 1, 1928).

10. METHODS AND PRINCIPLES OF SYSTEMATIC ZOOLOGY. By Ernst Mayr, E. Gorton Linsley, Robert L. Usinger (McGraw-Hill Book Company Inc., New York, Toronto, London, 1953).

11. THE DUCKS OF INDIA: Their Habits, Breeding Grounds and Migrations, together with other useful information for the Sportsman and Observer. By R. G. Wright and Douglas Dewar (H. F. & G. Witherby, 326 High Holborn, London, W. C. 1, 1925.)

Presented:

1. NOTES ON THE FIELD OCCURRENCE AND PETROGRAPHY OF THE ROCKS OF THE BOMBAY ISLAND, BOMBAY. By R. N. Sukheswala (Excerpt from the *Trans. of the Mining, Geological and Metallurgical Institute of India*, Vol. 50, No. 3, October 1953).

2. PLEA FOR MERCY TO ANIMALS. By James Macaulay (The Religious Tract Society, London).

3. A NARRATIVE OF TRAVELS ON THE AMAZON AND RIO NEGRO WITH AN ACCOUNT OF THE NATIVE TRIBES AND OBSERVATIONS ON THE CLIMATE, GEOLOGY AND NATURAL HISTORY OF THE AMAZON VALLEY. By Alfred Russel Wallace (Ward, Lock & Co., London, 1889).

5. Killing for Sport. Edited by Henry S. Salt (G. Bell & Sons Ltd., London, 1915).

6. Hunting Camps in Wood and Wilderness. By H. Hesketh Prichard (Thomas Nelson & Sons Ltd., London, 1910).

7. Through the Heart of Patagonia. By H. Hesketh Prichard (Thomas Nelson & Sons, London, 1911).

8. From Fiji to the Cannibal Islands. By Beatrice Grimshaw (Thomas Nelson & Sons Ltd., London).

9. The Tigers of Trengganu. By Lt.-Col. A. Locke (Charles Scribner's Sons, N.Y., 1954).

10. Stray Feathers from a Bird Man's Desk. By Austin L. Rand (Doubleday & Company, Inc., Garden City, N.Y., 1955).

11. The Biltmore Story: Recollections of the Beginning of Forestry in the United States. By Carl Alwin Schenck (Minnesota Historical Society, St. Paul, 1955).

12. Strange Creatures of the Sea. By A. Hyatt Verril (L. C. Page & Company, Boston, 1955).

13. Butterflies of the Indian Region. By M. A. Wynter-Blyth (The Bombay Natural History Society, Bombay, 1957).

MISCELLANEOUS NOTES

1. THE ABOMINABLE SNOWMAN

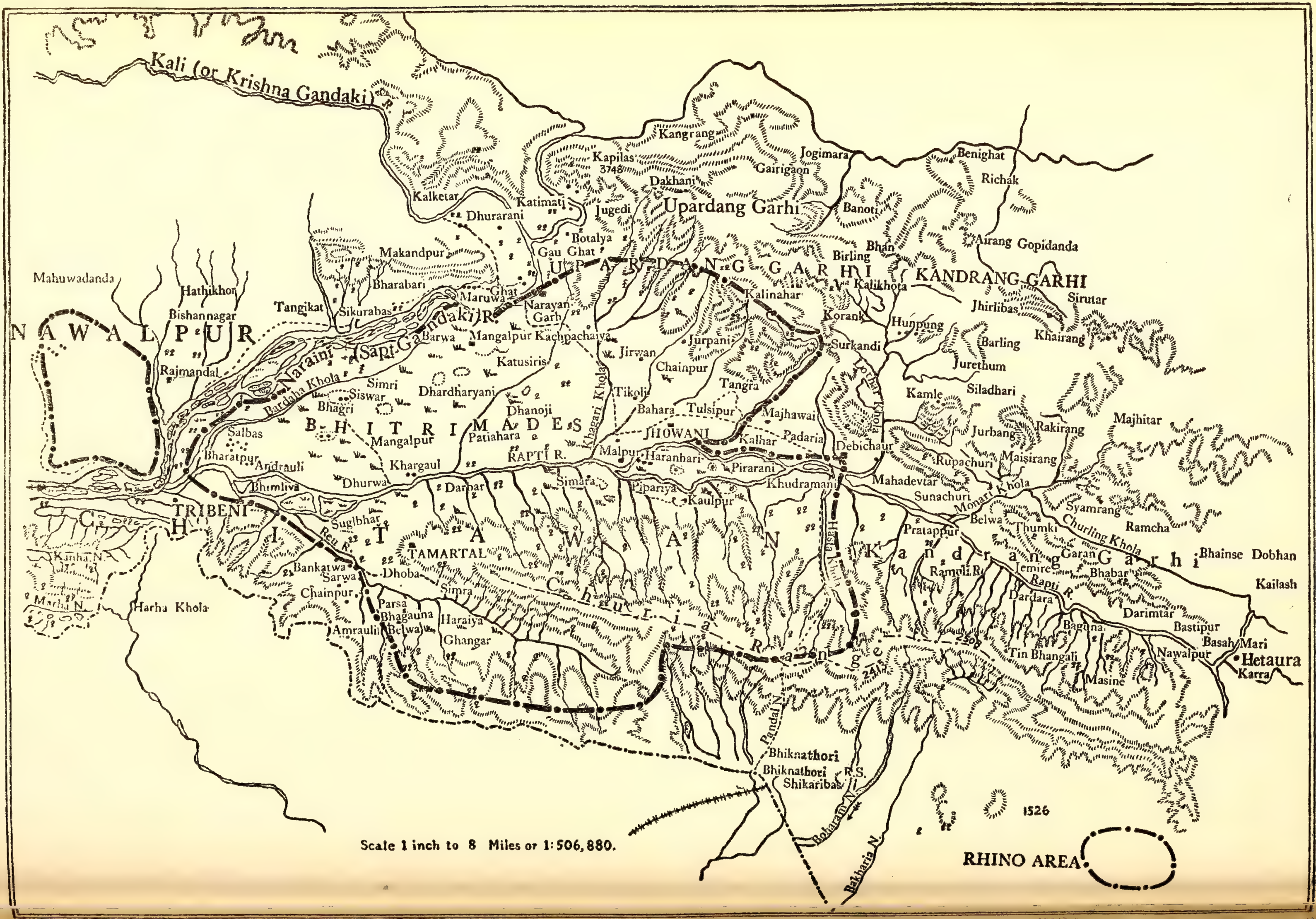
'The Abominable Snowman' by Swami Pranavananda in the April issue of the *Journal* is an interesting paper, but I think that the author rather lightly dismisses the 'sensational news, stories, and legends regarding the Abominable Snowman'. He may be right in his conclusion that the so-called Snowman is only a Red Bear, but the evidence that he sets out does not justify so downright a conclusion, and before coming to this finding he should have dealt with the material and arguments by which the exponents of the opposite view have sought to support their opinion.

He comments on the fact that so few people have seen the Abominable Snowman, but he himself quotes the shepherds on the Kyang Chhu who saw the animal which attacked their sheep. According to them it was light red or reddish brown in colour and about the height of a man. It ran away on all fours, but when it had got some distance from them it stood up and walked away on two legs. He mentions also the animal seen at Tomomopo in Tag Valley, a little taller than a man, colour deep brown, thick coat of reddish brown hair, hairs on face 'pretty long'. He himself in his book EXPLORATION IN TIBET classifies the fauna of Kailas-Manas region into: (1) *tom* black bear, (2) *te* brown bear, (3) *mi-te* man-bear, and in the present paper he accepts as a distinguishing character of the *mi-te* that it 'sometimes walks on hind legs only'. So it is possible, as believed by the opposite school, that the *mi-te* is not just an ordinary bear.

Charles Stonor, who led the *Daily Mail* expedition, made careful enquiries about the Abominable Snowman and his enquiries included persons whose knowledge extended to Tibet as well as Nepal. He took care to avoid asking leading questions and he found a fairly definite picture of the creature existing in people's minds. The people questioned by him were acquainted with the appearance of a bear and they were generally agreed that the *mi-te* was not a bear. The expedition found tracks on more than one occasion, generally of a creature walking on two feet; it appeared to them that the animal went on all fours only when it was in difficulties or in a hurry. They also found evidence which suggested that, before eating, the animal removes the entrails of its prey, an action which one would not ordinarily associate with a bear.

An eye-witness account of the animal is given by Slavomir Rawicz in THE LONG WALK. The author says that he and his companions observed two of these animals for two hours. They walked on their hind legs and did not drop on all fours throughout the time that they watched. The description tallies generally with the descriptions given to Charles Stonor in his enquiry, except that Rawicz makes the animal taller than it would be according to Charles Stonor.

In his Miscellaneous Note of 6 November 1956 at page 448 of the same issue of the *Journal* Swami Pranavananda speaks of footprints which he himself saw. Occasionally 'there were three or rather 2½


Kali (or Krishna Gandaki) R.
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Kapilas
3748
Jogimara
Gairigaon
Benighat
Richak
Dakhani
Upardang Garhi
Banoti
Kalketar
Katimati
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Botalya
Gau Ghat
Airang Gopidanda
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Kalinahar
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Jhirlibas
Sirutar
Tangikat
Sikurabas
Bishannagar
Gandaki R.
Barwa
Mangalpur
Kachpachaiya
Hunpung
Khairang
Surkandi
Barling
N A W A L P U R
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(Sapt Gandaki)
Jirwan
Jurpani
Rajmandal
Katusiris
Chainpur
Jurethum
Bardaha Khola
Simri
Siswar
Dhardharyani
Tangra
Kamle
Siladhari
Bhagri
Tikoli
Lothar Khola
Khagari Khola
Majhitar
B H I T R I M A D E S
Dhanoji
Bahara
Tulsipur
Majhawai
Salbas
Mangalpur
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JHOWANI
Kalhar
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Jurbang
Rakirang
RAPTI R.
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Haranhari
Debichaur
Rupachuri
Maisirang
Bharatpur
Andrauli
Khargaul
Pirarani
Mahadevtar
Dhurwa
Simara
Khudramani
Monari Khola
Bhimliya
Darbar
Pipariya
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TRIBENI
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Ramoli R.
Jemire
Bhabar
Kailash
Sarwa
Dhoba
Rapti R.
Marha N.
Harha Khola
Chainpur
Simra
Churia Range
Dardara
Darimtar
Parsa
Bhagauna
Haraiya
Bagana
Bastipur
Amrauli
Belwa
Ghangar
2509
Tin Bhangali
Basah
Mari
Nawalpur
Hetaura
Karra
241
Masine
Pandal N.
Bhiknathori
Bhiknathori R.S.
Shikaribas
Boharam N.
Bakharia N.
1526
RHINO AREA

Scale 1 inch to 8 Miles or 1:506,880.

footprints'. So, apparently, the creature walked mostly on two feet. This tallies with the accounts given to Charles Stonor. The area is one where Lord Curzon went to shoot Brown Bear, and Swami Pranavananda says that Black Bears are common in the neighbouring jungles. Hence the local people must be familiar with the footprints of bears, and at least some weight ought to be attached to their opinion that these footprints are of something which is not a bear.

A fantastic article about the animal appeared recently in a local paper and mentioned among other things the view of Sir Hugh Rankin, 'a noted Mahayana Buddhist and an experienced British mountaineer'. 'According to Sir Hugh, four . . . Bodhisattvas rule over the destinies of the world. One of them, the Abominable Snowman, has his habitat among the high Himālayan peaks. Another, known as Ferlas Mor, the local terror of the Scottish Highlands, lives in Ben Macdhui (in the Cairngorms) . . .'

We may not go as far as Sir Hugh, and we cannot accept without further proof the assertions of the believers in the Abominable Snowman, but we should keep an open mind.

49, Pali Hill,
Bandra,
Bombay 20,
June 30, 1957.

D. E. REUBEN,
I.C.S. (Retd.)

2. ON THE STATUS OF THE GREAT INDIAN RHINOCEROS (*R. UNICORNIS*) IN NEPAL

(*With a map*)

In April 1957 I had the good fortune to be sent by the Government of India to Nepal to assess the raw-material position for the proposed paper and pulp industry in that country, and I took the opportunity of investigating as closely as I could during my stay there the position and present status of *Rhinoceros unicornis*.

In view of the lack of information hitherto from Nepal as regards this rare animal, the guardianship of which that country shares with Assam and Bengal, the chance of making an on-the-spot enquiry was welcomed by me. I paid a short visit to the famous Chitawan area in the Rapti Valley which has for many years been the shooting preserve of the kings and the prime ministers of Nepal. I was accompanied by the local Circle Officer (Conservator), the local Divisional Forest Officer, and the Officer-in-charge of the Rhino Protection Staff, and so I was in a position to obtain first-hand information.

On my return to Kathmandu I re-checked the facts with the Chief Forest Officer and with Capt. Sher Jung Thapa, one of the forest officers who has had considerable experience of the locality and who is a keen shikari. I also discussed the question with Mr. Boris Lisonovitch who is running the Royal Hotel in Kathmandu and who is keenly interested in the question of the rhino and its preservation.

Smythies's book BIG GAME SHOOTING IN NEPAL has referred to this famous game reserve of Nepal as 'glorious Chitawan'. It consists of the valley of the Rapti River west of Hetaura after that river has turned westwards, and it is bounded on the north by the Mahabarata Mountains, on the south by the Churia or Siwalik Ranges, on the west by the Naraini River and on the east by the Ramuli River. The whole area is a big dūn or valley between the outer Siwaliks or Churia range and the inner Mahabarata or Himalayas. The Siwaliks or Churia range on the south consists of a double line of hills with the Reu River, the chief tributary of the Rapti, between them. Smythies describes the famous shooting preserve as being roughly pear-shaped, 4 or 5 miles broad at the eastern end at Hetaura, widening to 25 miles or more at the western end, and covering in all nearly 1,000 square miles. He was writing in 1942. The effective rhino area today is shown within the broken line on the map. It is approximately 200 square miles north of the Churia ranges, with another 200 square miles to the south of these hills—a strip 4 miles wide and 50 miles long—from Bhiknathori on the east to Tribeni, the junction-point of the Rapti and Naraini rivers, on the west. The habitat consists partly of tree-forest both sal and miscellaneous deciduous, and partly of grassland both low-lying and swampy, interspersed with cultivation, the best area being to the north of the Churia ranges from Jhowani to Bharatpur. West of the Naraini, in what is known as the Nawalpur area, there is another 100 square miles which contains rhino. Thus there are some 500 square miles gross, 400 to the east of the Naraini and 100 to the west of that river, which together form the main home of the Nepal rhino. There are said to be a few rhinos scattered in the Kosi area to the east, but to all intents and purposes the Chitawan area is the only one worth considering when the question of preservation of the Nepal rhino on a long-term basis is considered.

The estimated population of rhinoceroses according to the Forest Department of Nepal is some 400-600 in the Chitawan area and some 100 in the Nawalpur area, or say 500 to 600 on the whole. In 1953 their estimate was 1,000 rhinos.

The Rapti Multi-Purpose Scheme is to take in the bulk of the high-land grass area now being cultivated by the Tharus with their primitive ploughs. Tractors are already breaking up the lands and it is planned to settle here a number of people from the hills whose agriculture is in a precarious state. The soil is light and sandy, and unless irrigation and fertilisers are brought to the lands in question, the cultivation will be purely temporary for a few years, in my opinion. Whatever may eventuate, however, the fact is that 80 to 100 of the 400 square miles in the Chitawan area, the main home of the Nepal rhino, is going to be denied to them in a couple of years, and we will have only 300 square miles in the region east of the Naraini to accommodate the 400 to 600 rhinos which are said to be there now. This will work out to almost 1½ rhinos per square mile on an even distribution, which in my opinion is too high.

Mr. Boris Lisonovitch also considers the estimate of 400 to 600 rhinos in the Chitawan area as being an over-estimate and thinks that there are not more than 300 rhinos in that area. I am inclined to agree with him for the following reasons.

The Nepal rhino lives in comparatively drier habitat than the Assam animal to judge from the conditions seen by me. Moreover they are living in closer proximity to habitation and cultivation and wander freely about the country which is sparsely populated by Tharus who cultivate both high-lands and low-lands. The high-land grassy plains are, as it were, shared by the Tharus and the rhinoceros during the rains when the grass is vigorous, while the low-land areas bordering the Rapti are almost exclusively inhabited by the rhinoceros, and are their refuge when the high-land grass is burnt. When I saw the area the grassy lands had been largely burnt and all the animals appeared to be concentrated in the lower swampy and wooded regions near the river, to the south of the main dūn. The concentration of rhinos seemed heavy and near Jhowani we put up, within half a mile of the village, 4 rhinos within an area of a square mile, 3 of which were in tree-forest and only one was wallowing near the river. They were very shy and dashed about snorting and obviously terrified, and no wonder since they are shot to the tune of 6 to 8 in the royal shoots and 20 to 40 by poachers annually.

The high-land grassy areas are the corridors for movement from the Rapti River on the south to the Mahabarata Hills on the north and the Naraini on the west. Apart from the swampy areas near the Rapti and the forests, the only refuge (and that of a temporary nature), which will be left to them will be the large patches of sal forests fringing the plain. Turning to the possible repercussions on the rhino population, it is easy to predict that if one-third of the gross area is denied to them the pressure on the lower lands near the Rapti and the Churia ranges is going to be considerable, particularly in the mating season in March-April. This will have its inevitable effect on the population of rhinos which, in my opinion, will fall drastically, so that at a conservative estimate the numbers to the east of the Naraini River is not likely to be more than 300 at the most in a few years. Whether the population in the Nawalpur area west of the Naraini will remain at the present estimate of 100 is also doubtful since this area is less easy to protect than the Chitawan area. The present plan of the forest department is to demarcate the area shown within the broken line on the map as a permanent sanctuary, leaving the lands of Tharu cultivation within the area, but also demarcated and restricted to existing cultivation of a permanent nature only.

In any case, assuming the figure of rhino population assessed at present as correct, Nepal can claim to have as many rhinoceroses as Assam and Bengal put together, if not more. In other words 50% at least of the estimated population of the Great Indian Rhinoceros in the Indian sub-continent is in Nepal. This is a very great advance on the reports which we have received up to now.

Turning to the question of protection of this valuable and vanishing animal in Nepal, it is encouraging to note that there is a special Rhino Protection Officer with the rank of Captain, and under him a staff of 152 consisting of the following:

1	Asstt. (Lieutenant)
4	Subehdars
24	Havildars
122	Forest Guards

There are 60 chowkis, 45 in the Chitawan area and 15 in the Nawalpur area, each manned by 2 Forest Guards and it was encouraging to note that on the only road or track in the area lorries are not permitted to travel at night. But the provision of only one elephant to the Rhino Protection Officer for movement in very difficult country seems totally inadequate. In spite of this comparatively large protection force, poaching is said to be rampant and every year 20 to 30 rhino carcasses are found with their horns missing. (While I was in Nepal a skirmish had taken place between a gang of poachers who had been isolated on a hill and surrounded, but not before 4 rhinos had been killed, one with 12 bullets, though no horns could be removed.) There appears to be a regular trade in rhino horns and the hill-men who are supposed to be the poachers in question come down regularly to slaughter the precious animal under the very noses of the protection staff. The market for rhino horns is China and it is stated that some V.I.Ps. from that country purchased a large quantity of horns at a very high price on their recent visit to Nepal. The fact that permission was sought to export 109 rhino skins from Nepal, as reported by the Secretary-General of the Indian Board for Wild Life recently, is an indication of the rate of destruction.

In the old days under the Rana regime the rhino was so closely guarded that a man could lose his life for having killed one. It was considered the royal prerogative and the only persons who could kill it were the king and the prime minister and the members of their families, and distinguished guests. Today this still holds good, but with the collapse of the Rana rule and the introduction of democratic self-government poaching appears to be on the increase. The only hopeful signs are the interest of the Government of Nepal in the protection of the rhinoceros and the keenness of the forest officers whom I met.

14 New Forest,
Dehra Dun, U.P.
May 22, 1957.

P. D. STRACEY, I.F.S.

3. THE SPINY BABBLER IN KATHMANDU VALLEY

On March 27th, 1957, I got a Spiny Babbler [*Turdoides nipalensis* (Hodgson)] from Nagarjung at 4,700 ft. It is a male bird and one of a party of three. During the past nine years sixteen other specimens have been collected, all from west Nepal and all found between 3,000 and 4,800 ft. This Kathmandu Valley bird is the first from central Nepal and comes from the upper known altitudinal range.

This babbler—testes slightly enlarged and apparently preparing to breed—called loudly from a bush on the northern slopes of Nagarjung not far above cultivated fields. The steep hillside is thickly covered with scrub and fern (*Gleichenia linearis*) about waist high with here and there a tree or good-sized shrub. The notes sounded like 'gay téeter, téeter, téeter, karéek,' each 'teeter' a note lower than the last, ending with an up-swing on 'kareek' and an emphasis on the last syllable. Following the report of the gun I heard a bird call from under the vegetation 'gay du-du-du-du-du-du-du,' the notes following one another in rapid succession with an overall drop of about three notes. I also disturbed a pair of Rustycheeked Scimitar Babblers (*Pomatorhinus erythrogenys ferrugilatus* Hodgson) hidden on the ground about fifteen yards away.

Ten minutes later a Scimitar Babbler climbed out of the vegetation on to the top of a shrub and flew diagonally uphill followed by a second one. A moment later a Spiny Babbler appeared and flew to the low trunk of a leaning tree on the level with the scrub jungle around it. A second followed it; they flew from the base of the first tree to the base of a second tree in succession then dropped on to the ground. I surprised both birds ten yards on in the middle of the path ahead of me. They flew together within a foot of each other, with even, rapid wing beats and settled in the middle of bushes about ten or twelve feet high. Just then a woman with a load of green leaves came noisily up the path and both birds dropped out of sight.

Of the several males I have collected, this easternmost specimen is much darker on the head and upper breast than the others. The pure white colour is restricted to the chin and one side of the neck only with none on the head. The feathers over the eye are pale brown while the ear-coverts are mixed with silver and brown. Characteristically, the quills of most feathers except wings and tail are prominent, often extending beyond the rest of the feather which is worn and irregular along the margins.

Mrs. Desiré Proud reported a sight record of *T. nipalensis* from her garden several years ago and until now there was no other evidence that this is a species of our Valley.

Area Superintendent,
United Mission to Nepal,
Shanta Bhawan, Patan
Kathmandu, Nepal,
March 29, 1957.

R. L. FLEMING

4. 'A DABCHICK IS BORN'

The description by Mr. Loke Wan-Tho (Vol. 53, p. 469) of the hatching out of a dabchick takes my memory back more than seventy years.

On an evening in 1886, standing on the bank of a pond in the grounds of Heathfield House in Sussex, I quite by chance witnessed the hatching out of several moorhen chicks. The shells of the eggs appeared to be disrupted in quick succession and the chicks almost at once left the reedy platform which was the nest and swam away. The parents were not just then seen.

The incident made a great impression on my mind, and is even now vivid after all these years.

c/o Lloyds Bank Ltd.,
39, Piccadilly, W. I.,
February 4, 1957.

R. W. BURTON,
Lt.-Col., I.A. (Retd.)

5. BIRD LIFE OF MADHYA PRADESH

I was particularly interested in Mr. Hewetson's article on the birds of Madhya Pradesh [*JBNHS*, 53 (4): 595-645], since I visited Madhya Pradesh at various times between the years 1927 and 1954, mostly for quite short periods, but I took every opportunity of watching birds. My most frequent visits were paid to the Hoshangabad District and to Wardha, but in the course of the years I visited some other parts too.

The following brief notes may perhaps be useful as a slight addition to Mr. Hewetson's article, especially with reference to the warblers, a group that has always attracted me. One of my favourite occupations has always been to stand for many minutes watching some small Warbler till it would really show itself—as often as not it would refuse to reward my patience.

Mr. Hewetson says that *Acrocephalus dumetorum*, Blyth's Reed Warbler, occurs, but he has no certain records. I have watched them frequently, at close quarters, both in various parts of the Hoshangabad District and near Wardha. I have only rather doubtful records of *A. agricola* at Wardha, but *Hippolais scita*, the Booted Warbler, of which Mr. Hewetson has no record, seems to me to be quite the commonest of the small brown warblers in the winter, except for the Siberian Chiffchaff. I have seen the Booted Warbler in scrub at the edge of jungle as well as in more open country in the Narbada Valley, also at Wardha.

Of the *Phylloscopus* group, other than *P. collybitus*, the Chiffchaff, the two other common species, which I have found round every compound where I have stayed, are *P. trochiloides*, the Greenish Warbler, and *P. inornatus humei*. *P. trochiloides* is specially common also on the edge of jungle. *P. griseolus*, which Osmaston (*JBNHS*, 28: 455) has recorded from Pachmarhi, I have several times found in the jungle near Itarsi and Makoriya, Hoshangabad District; and I once caught one fluttering against a window on the outskirts of the Sanchi Temple—then, of course, part of the State of Bhopal. I also recall that Mr. Sálim Ali procured a specimen of *P. affinis* when I was birding with him at Melghat, Madhya Pradesh, on February 7, 1951. Mr. Hewetson possibly overlooked a note of mine in the *Journal* for August 1948, which gave some evidence for the occurrence of *P. fuscatus* in the Hoshangabad District, and also referred to several of the other members of the genus seen there.

On the other hand, I have quite failed to find *Acanthopneuste* (now usually treated as a *Phylloscopus*) *occipitalis* in any part of the Madhya Pradesh jungle that I have visited in winter. It is a rather easy species to identify, and it is certainly plentiful in the hills of south India. It is quite likely to occur in the hills of Madhya Pradesh, as for instance near Pachmarhi, which I have only visited in the summer. As I gather that Mr. Hewetson does not claim to be very well acquainted with this difficult group, I hope he will not mind my questioning his view that this species is seen all over the forest as well as more open country. Did he perhaps confuse it with *P. trochiloides*?[1]

Whilst I am writing, I may add one further note about the White-rumped Spinetail (*Indicapus sylvaticus*). Mr. Hewetson records it from the Seoni District on the authority of D'Abreu, from whom, I suppose, Stuart Baker obtained his information to the same effect. But Mr. Hewetson has not himself found it. It may be of interest, therefore, to record that, as we were passing through the Seoni District, on November 4, 1953, travelling from a meeting of the Indian Board for Wild Life to Nagapur, R. S. Dharmakumarsinhji and I saw numbers over a jungle pool of water where we stopped for our lunch. We had ample opportunity for watching them, and on return to our reference books, we both independently tracked them down as this species, though I believe neither of us had any idea that this bird of curiously erratic distribution was found within hundreds of miles of Nagpur.[2]

114 Oak Tree Lane,
Birmingham 29,
England,
March 5, 1957.

H. G. ALEXANDER

6. REFLECTED GLOW FROM THE EYES OF THE GHARIAL [*GAVIALUS GANGETICUS* (GMELIN)]

I recently had occasion to handle a few live gharials (*Gavialus gangeticus*) in transit to the New York Zoological Park. Their despatch was delayed for some time as the Customs held that they were 'crocodile skins' and, under the current regulations, could not be exported without a permit from the Secretary-General of the Indian Board for Wild Life!

During this time they were left in a fish pond (without fish) in a friend's garden. As they were prone to climb out and wander away, I looked them up at night on several occasions, and it was noticeable that their eyes did not reflect torch-light as is customary with the Marsh Crocodile *C. palustris,* which can be thus spotted at considerable distances.

Later, Dr. James Oliver of the New York Zoological Society carried out similar experiments and wrote: 'We, too, were not successful in getting the eyes to reflect light until we learned that there was only a small area in which the light could be reflected. The colour is a much fainter glow than in other crocodiles'.

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[1] Specimens of *Phylloscopus o. occipitalis* have been obtained by Sálim Ali in winter at Pakhal Lake, Warangal Dist., Andhra, in the Bastar Dist. of Madhya Pradesh, and also in what were formerly the Indore and Dhar States—in the latter as early as between 24 August and 7 September.—Eds.

[2] Also observed by Sálim Ali at Makri (near Amraoti) in the Bastar District of Madhya Pradesh, December 27, 1948.—Eds.

Relatively little has been recorded of the habits of this species, and one wonders if the above difference may not be an indication of its being possibly less nocturnal than the others?

MESSRS. FAIZ & CO.,
75, ABDUL REHMAN STREET,
BOMBAY-3,
April 18, 1957.

HUMAYUN ABDULALI

7. OCCURRENCE OF A RARE STING RAY [*TAENIURA MELANOSPILA* (BLEEKER)] IN BOMBAY WATERS

(*With one plate and one text figure*)

During one of the trips for collecting live fishes for the Taraporevala Aquarium in September 1955, a female ray fish was caught on the foreshore at Mahaluxmi (part of Bombay city) and was brought alive for exhibition at the Aquarium. The specimen appeared to be not one of the common rays caught in local waters, as recorded by Setna and Sarangdhar (1943, 1946)[1]. Its identification was deferred till it died nearly eight months later, when it was found to be *Taeniura melanospila* (Bleeker).

Smith (1952) reports that this fish is rare in Batavia, Java, Celebes, Ceylon, Muscat, the Red Sea, and South Africa. The only record of its occurrence in India is by Day (1878-1888), who based his account on the notes of Elliot and Jerdon who obtained two specimens from the Coromandel coast in 1853. The description given by Day is, consequently, inadequate and does not help materially in the identification of the species. Nor are there any entire specimens of the fish in the laboratories of the Zoological Survey of India, Calcutta. Thus the present record has not only confirmed its rarity in India, as indicated by Smith, but has also provided an opportunity for a detailed examination of an entire specimen which was not available so far in India. The systematic description of the species is as follows:—

Taeniura melanospila (Bleeker):

Taeniura melanospilos, Bleeker, *Nat. Tyd. Ned. Ind.* p. 513 (1853).
Taeniura melanospila, Günther, *Cat. Fish. Brit. Mus.* **8**, p. 484 (1870).
Day, *Fishes of India*, p. 740 (1878–1888).
— —, *Fauna of British India, Fishes* **1**, p. 56 (1889).
Southwell, *Rep. Ceylon Marine Lab.* **1**, p. 185 (1910).
— — — —, *Ceylon Administr. Rep.*, pp. E 43, E 49 (1912–1913).
Deraniyagala, *Ceylon Journ. Sci.* (c) **5**, p. 81 (1933).
Smith, *Ann. Mag. Nat. Hist.* (12) **5**, pp. 1020–1025 (1952).
— —, *The Sea Fishes of Southern Africa*, pp. 513, 514 (1953).
Taeniura lymma (in part) Fowler, *Bull. U.S. Nat. Mus.* (100) **13**, p. 398 (1941).
Misra, *Rec. Ind. Mus.* **45**, p. 32 (1947).
— —, *Rec. Ind. Mus.* **49**, pp. 121, 122 (1952).

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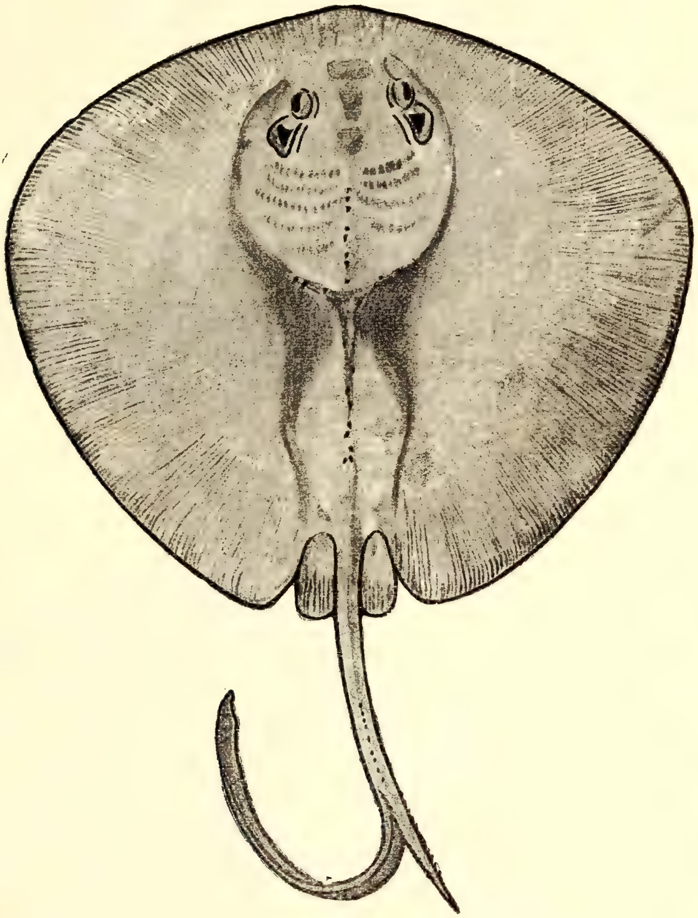
[1] Setna, S. B. (1943): *Curr. Sci.* (12), p. 302.
Setna, S. B., & Sarangdhar, P. N. (1946): *Proc. Nat. Inst. Sci. India* 12, pp. 243-259.

The disc is subcircular, slightly wider than long, without any pectoral angles. The anterior contour is rounded, the position of the tip of the snout being marked by a small terminal projection. The axis of greatest breadth is at seven-sixteenth of the distance behind the tip of the snout. The eyes are small, with a horny projection of the iris extending out laterally and shielding the pupil from above. The spiracles are larger than the eyes, and are closely approximated to their posterior borders.



Text figure 1. *Taeniura melanospila* (Bleeker). Dorsal view showing median tubercles.

The tail is slightly longer than the disc. Its proximal part has a broad ridge which is the continuation of a ridge on the dorsal surface of the disc. The single dorsal spine on the tail bears about 45 anteriorly directed serrations on each side. On the ventral surface of the tail is a well-developed cutaneous fold which starts from below the origin of the spine and extends right up to the tip.

The skin is soft and bears numerous stellate, sandpaper-like denticles scattered all over the disc except for a very narrow marginal area. The denticles are more pronounced on the tail. Along the midline of the back, a spiracle-length behind the spiracles, is a row of eight close-set tubercles. Behind this, there is another row of eight smaller, irregularly spaced tubercles. On the humeral region, less than an eye diameter from the median line of tubercles, starts, on each side, a row of three tubercles.

Inside the mouth are three buccal processes—one in the middle, and two rather widely spaced lateral ones.

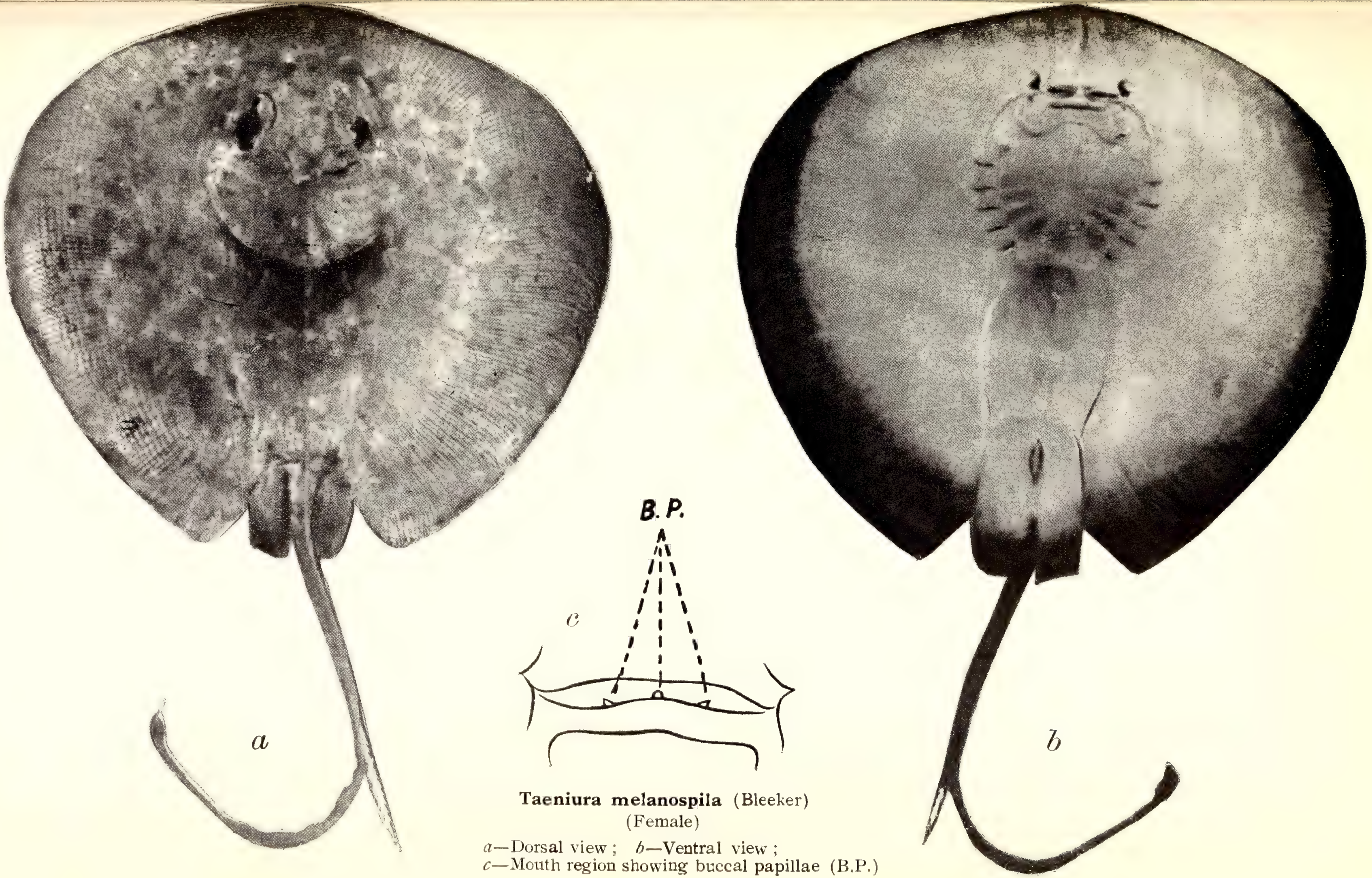
Colour of the dorsal surface of the disc is light brown mottled with numerous, irregularly-shaped, chocolate-brown spots and patches. The ventral surface is white with a greyish brown border posterior to the level of the mouth. The tail is dark throughout.

MEASUREMENTS

Characters	*Measurement in mm.*
Total length	837
Length of disc	400
Breadth of disc	452
Length of tail	437
Tip of snout to anterior border of eye	84
Tip of snout to anterior border of spiracle	102
Longitudinal diameter of eye	25
Maximum diameter of spiracle	31
Preorbital length	80
Interorbital length	42
Preoral length	56
Gape of mouth	42
Internarial length	54
Length of caudal spine	70
Width of tail at base	25
Depth of tail at base	23
Tip of snout to vent	322

The main characteristics of the present specimen conform to the description of the species given by Smith (1952). There are, however, a few minor differences:

South African specimen	*Local specimen*
1. Maximum width of disc immediately behind level of hind margin of spiracles.	Maximum width of disc far behind spiracles.
2. Many tubercles on disc.	Few tubercles on disc.
3. Tail thick at base, with two serrated spines.	Tail slender at base, with one serrated spine (no vestige of a second spine on tail, nor any scar indicating a broken spine).
4. Lateral and hind edges of disc darker in colour than rest of body.	Disc uniformly coloured throughout.
5. Ventral surface of disc uniformly light.	Ventral surface of disc white, with a greyish brown border posterior to the level of mouth.



Taeniura melanospila (Bleeker)
(Female)

a—Dorsal view ; *b*—Ventral view ;
c—Mouth region showing buccal papillae (B.P.)

Günther (1870) (op. cit. Smith) mentions that the fish has two papillae on the bottom of the mouth. As compared with this, three buccal papillae were observed in the local specimen and in the one examined by Smith.

Fowler (1941) and Misra (1947, 1952) consider *Taeniura melanospila* to be synonymous with *T. lymma*. But Smith (1952, 1953) regards both these as two distinct species, on the following basis. In *T. melanospila* the disc is slightly wider than long, while in *T. lymma* it is much longer than broad. Also, the colour of the disc in *T. melanospila* is light brown mottled with irregular chocolate-brown spots, and in *T. lymma* it is pale red with large blue spots. The tail in *T. lymma* has two broad blue stripes on the sides. The eyes are large, almost equal in size to the spiracles, in *T. lymma* than in *T. melanospila*.

The local specimen constitutes the first record of this fish from Bombay waters, and the second from India. As there is no complete specimen of this fish in the reference collection of the Zoological Survey of India, the specimen will be deposited in that laboratory.

We are grateful to Dr. C. V. Kulkarni, Director of Fisheries, Bombay, for pointing out to us the rarity of the specimen from its external appearance while it was alive in the exhibition tank. We are also thankful to Dr. K. N. Misra, of the Zoological Survey of India, for his valuable suggestions.

TARAPOREVALA MARINE,
BIOLOGICAL STATION,
BOMBAY,
May 19, 1957

H. G. KEWALRAMANI
B. F. CHHAPGAR

8. THE 'MARALA'—A SINK NET USED IN THE BACKWATERS OF GANJAM, ORISSA

(*With two text figures*)

Sink nets, also known as blanket nets, are effective forms of fishing gear widely used in different parts of the world. In India, they are represented by the 'mada valai', a net used extensively on the Coromandel coast, and by a few other similar nets.

A sink net is square-shaped and made up of different pieces of netting, the mesh-sizes decreasing from the periphery towards the centre (fig. 1). The principle of operation is quite simple. The net is normally used from four fishing boats, one in each corner, as a lift entrapping structure. At first, it is sunk and kept suspended by means of four ropes attached to the corners. When the fishermen operating the net, feel that some fish have assembled on the upper side of the net, the net is quickly hauled to the surface.

In Orissa, the 'marala' is a large-sized sink net operated in shallow backwaters, about five to fifteen feet deep, in the district of Ganjam. The net is used chiefly by some fishermen around Damodarpur, Gopalpur, and Sonapur. It does not appear to have been described in earlier publications.

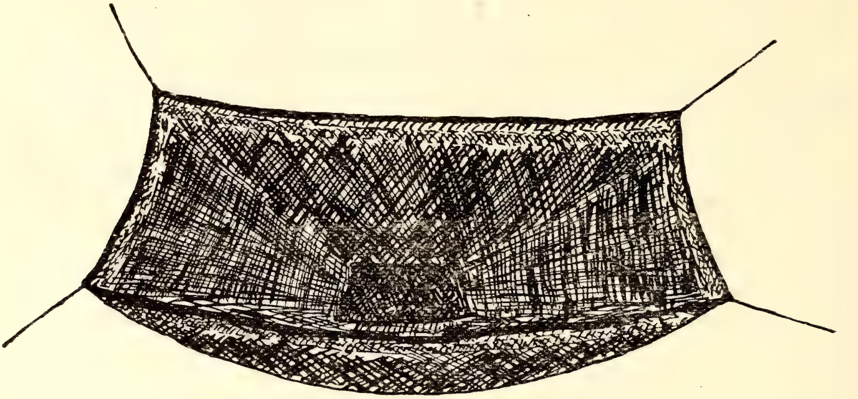


Fig. 1. The 'marala'—a sink net used in the backwaters of Ganjam, Orissa.

The dimensions of a typical 'marala' from Gopalpur, the different parts of which are shown in the diagram (fig. 2), will serve as an example. Each side of the square measures 96 ft., and to each corner is attached a thick hemp rope at the time of operation. The net itself is made of cotton twine. The outermost margin is usually strengthened by a hemp rope on all the four sides of the net. The peripheral strip is 4½ ft. in breath on each side, and the mesh (stretched) is 2 inches. The next inner strip is also 4½ ft. deep, with a mesh size of 1 inch. The length of each side of this strip measures 87 ft. and 78 ft. on the outer and inner margins respectively. The third portion, i.e. the netting in between the second outer strip and the central square or bunt is the largest in area, each side measuring 78 ft. on the outer margin. The twine is slightly thicker than that used for the outer strips and the size of the mesh is ½ in. The central square, 18 ft. by 18 ft. is made of much thicker twine and has a mesh size of ¼ inch, so as to retain and capture small fishes like sardines and anchovies.

During operation, the net is sunk to the bottom, and about a dozen fishermen in four dug-outs, each about 15 to 20 ft. in length, diverge in opposite directions, at the same time releasing the ropes connected to the corners of the net. On reaching the ends of the ropes, they start beating and splashing the water to scare the fish towards the centre of the net, while the dug-outs, converge gradually towards the net. As soon as the fishermen approach the net, the ropes are pulled and the net lifted to the surface, and all the fish within are then collected in the bunt. This central portion has a natural tendency to become a shallow pouch during fishing, and it is, therefore, felt not necessary to modify the existing gear as it is only used for fishing in shallow waters.

This gear is quite effective in such shallow waters, as it is able to capture all the medium and large-sized fish entrapped between the upper surface of the net and the water surface. Other advantages of the net are its simple construction and easy operation.

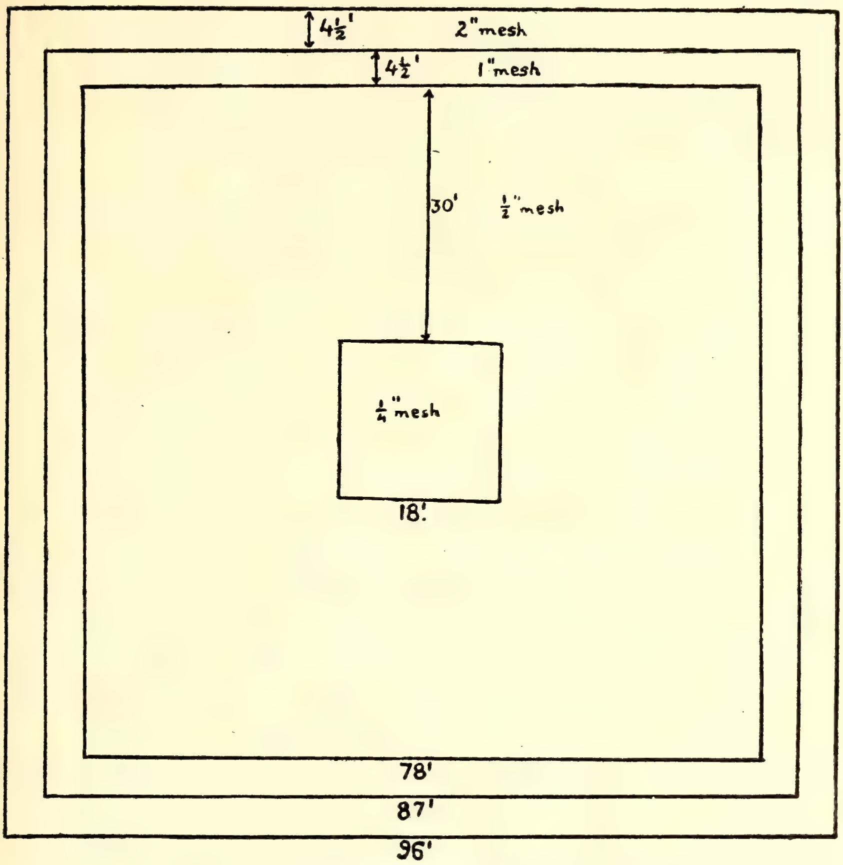


Fig. 2. Diagrammatic sketch of typical ' marala '.

Modification of the 'marala' on the principle of some deep water sink nets could be made by providing a pouch-like cod-end with small purse rings in the middle of the bunt, if it is utilised for sea fishing.

Department of Fisheries,
Orissa,
Cuttack,
December 1, 1956.

P. MOHAPATRA

9. MIGRATION OF INSECTS

In 1938 (*JBNHS*, 40: 439-457) we published a note by Dr. C. B. Williams on the migration of butterflies in India, which summarized the information then available. There has been very little additional information in India, but Dr. Williams and others have recently contributed a paper entitled 'Observations on the Migration of Insects in the Pyrenees in the Autumn of 1953' in *Transactions of the Royal Entomological Society of London*, 108 (9): 385-407, from which it appears that in addition to the migration of butterflies there are such regular movements in various forms of Diptera (flies) as also other insects. Most mass movements of insects other than locusts have been looked upon as having been brought about by changes in the wind, but Dr. Williams and his associates have experimentally established that this is not so, and that insects of several species carry out regular migrations independent of the direction of the wind. It would be interesting to examine associated matters in India and ascertain what insects, if any, undertake migration here.

114 Apollo Street, EDITORS
March 12, 1957.

10. NOTES ON THE BUTTERFLIES OF RANGOON

As far as I can trace there appears to be no list of the butterflies of Rangoon though, of course, there are plenty of lists covering other localities in Burma.

My stay in Rangoon has been a short one, from the 14th July last year to the end of March 1957, so my list does not cover what may well be the most prolific period from April to July, and there are undoubtedly many more species to be added.

There is little or no forest near Rangoon now, though 30 or 40 years ago there must have been fairly thick rain forests, as some of the trees still remain here and there. There are patches of secondary and scrub jungle round Hlawga Lake, about 15 miles to the north of Rangoon, just beyond the Mingaladon Cantonment, and it was here most of my collecting was done. Even here it is unsafe to go far from the road owing to the activities of the insurgents and dacoits, so all the collecting in this area was round a small backwater of the lake, not more than half a mile square. Further north, for the next 50 miles or so, are the Pegu Yomas which look good collecting ground, but it is unsafe to enter this territory.

From July to the middle of October there was almost continuous heavy rain, but thereafter there has been no rain whatever, and from January to March there have been few butterflies on the wing.

For simplicity's sake I have used Evans's 'Identification of Indian Butterflies', 1932 edition, for all species except the Hesperiidae, where Evans's 'Catalogue of the Hesperiidae of Europe, Asia, and Australia' has been used for nomenclature. The latter of course is up-to-date, but there are many changes in the former.

I am grateful to Dr. T. Norman of Seleng Tea Estate, Assam, who has kindly identified some of the more difficult genera of Hesperiidae and Lycaenidae for me, where necessary by dissection of the genitalia.

The following is a list of butterflies positively identified in the area:

PAPILIONIDAE

1. **Troides helena cerberus** (Fd.)—Two males at Hlawga Lake on 30th September. Another in the city about mid-October.

2. **Tros varuna astorion** (Wd.)—A single male at Hlawga Lake on 30th September.

3. **Tros coon doubledayi** (Wall.)—A worn specimen at Hlawga Lake on 30th September, another in October, and a newly hatched female on 16th February.

4. **Tros aristolochiae goniopeltis** (Roth.)—This is not at all a common butterfly here and only three were seen—two in my garden and one at Hlawga Lake—all in August, and one more in my garden in November.

5. **Chilasa clytia onpape** (M.)—One only at Hlawga Lake on 16th February.

6. **Chilasa clytia** var. **dissimilis** Linn.—This seems to be much the commonest form here and they were not uncommon in my garden from July to September and again in February. In fact, there are more of this butterfly than of *Danais limniace mutina*. There were also a few at Hlawga Lake in January and February.

7. **Papilio memnon agenor** L.—Not common, but widespread over the area. I have not seen it at the Lake. The female form appears to be the tailed var. *alcanor* Cr., but is much scarcer than the male.

8. **Papilio polytes romulus** Cr.—Very common up to the end of December, after which it seems to have disappeared. The female form *stichius* Hub., is fairly common and possibly form *cyrus* may also occur, but I have not seen any.

9. **Papilio demoleus demoleus** L.—Very common.

10. **Zetides sarpedon sarpedon** (L.)—Very scarce, one tattered specimen in my garden in July and one at the Kokine Swimming Club in August.

11. **Zetides doson axion** (Fd.)—One tattered specimen in September in my garden.

12. **Zetides eurypylus cheronus** (Fruh.)—Fairly common from September to November.

13. **Zetides agamemnon agamemnon** L.—Common and widespread from July to January, after which they seem to disappear.

PIERIDAE

14. **Leptosia nina nina** (F.)—Very common everywhere.

15. **Delias eucharis** (Drury)—Two only in August. This is rare here though I may have overlooked some owing to their resemblance in flight to *D. hyparete.*

16. **Delias hyparete hierte** (Hub.)—This is very common everywhere.

17. **Delias thysbe pyramus** (Wall.)—Two at Inya Lake (Rangoon) in December and others in January and February.

18. **Huphina nerissa dapha** (M.)—Very common. The females are very variable and some of the darker ones look like a *Neptis* at first sight when hovering over flowers.

19. **Appias lyncida hippoides** M.—Fairly common at Hlawga Lake but not elsewhere. Females are very scarce and I took none.

20. **Appias albina darada** (Fd.)—Males are scarce and I only took two in my garden and one at the Lake, all in September. I have two females both taken in October which I think are of this species.

21. **Catopsilia crocale** (Cr.)—The commonest of this genus.

22. **Catopsilia pomona** (F.)—Not nearly so common as in other parts of the East. I took one female, var. *catilla* Cr., in my garden early October but saw no other of this variety.

23. **Catopsilia pyranthe minna** (Herbst)—Rather scarce. I have not seen more than a dozen all told.

24. **Catopsilia florella gnoma** (F.)—Scarcer even than *C. pyranthe.*

25. **Terias libythea** (F.)—Two only, both in my garden in September.

26. **Terias laeta sikkima** (M.)—Two at Hlawga Lake in September.

27. **Terias blanda silhetana** Wall.—One in my garden, one at Hlawga Lake in October.

28. **Terias hecabe hecabe** L.—This is the only *Terias* which is really common, and all except the above two that I have examined have been *hecabe*

29. **Ixias pyrene latifasciata** But.—Fairly common.

30. **Hebomoia glaucippe glaucippe** (L.)—Fairly common from July to end December, after which they are very scarce.

31. **Pareronia valeria hippia** (F.)—Very scarce—no females seen.

DANAIDAE

32. **Danais aglea melanoides** (M.)—Very scarce except during the month of October when several were seen daily, but by November they had disappeared.

33. **Danais agleoides** (Fd.) – A single specimen in my garden at the end of August and another in October. Two at Inya Lake in November.

34. **Danais similis vulgaris** (But.) – A single one at Hlawga Lake in September.

35. **Danais limniace mutina** Fruh.—Not at all common. I have not seen more than a dozen in the time I have been here.

36. **Danais mellissa septentrionis** But.—A single specimen at Hlawga Lake in October.

37. **Danais plexippus** (L.)—Not common. I have seen not more than six or eight.

38. **Danais melanippus indicus** (Fruh.)—Commoner than *D. plexippus*. I have found this very difficult to catch, and only have one.

39. **Danais chrysippus** (L.)—Much the commonest *Danaid*, but this genus as a whole is very scarce here compared to India.

40. **Euploea mulciber mulciber** (Cr.)—Very scarce. I have only seen one male and two females.

41. **Euploea godartii** Lucasi—The only common *Euploea*. I have bred this here.

SATYRIDAE

42. **Mycalesis perseus blasius** (F.)—Very common.

43. **Mycalesis mineus mineus** (L.)—Very common.

44. **Lethe europa niladana** Fruh.—Four in my garden, others at Hlawga August to February.

45. **Lethe rohria rohria** (F.)—One at Hlawga Lake in October.

46. **Ypthima hubneri hubneri** Kirby—Very common.

47. **Ypthima baldus baldus** (F.)—Only two, both at Hlawga Lake in December.

48. **Orsotrioena medus medus** (F.)—Rather scarce. Two in my garden in October and two more in December.

49. **Melanitis leda ismene** (Cr.)—Fairly common.

50. **Elymnias hypermnestra undularis** (Drury)—This is very scarce here and the males are difficult to distinguish from the sub-

species *tinctoria*. I am fairly sure both occur here, as the female var. *paraleuca* Fruh. most certainly does.

51. **Elymnias hypermnestra tinctoria** M.—Female var. *paraleuca* is a wonderful mimic of *Danais melanippus indicus* Fruh., and I am quite unable to tell them apart when in flight.

NYMPHALIDAE

52. **Charaxes polyxena hierax** Fd.—One seen at close quarters but missed, early October.

53. **Euthalia lepidea sthavara** Fruh.—A single one at Hlawga Lake in December.

54. **Euthalia garuda garuda** (M.)—Fairly common in my garden and at Hlawga Lake.

55. **Euthalia lubentina indica** Fruh.—Two males and a female on a mango tree in my garden.

56. **Parthenos sylvia gambrisius** (Fabricius)—I was surprised to see one at Hlawga Lake in September.

57. **Liminitis procris procris** (Cr.)—Fairly common.

58. **Pantoporia perius** (L.)—Common.

59. **Neptis columella ophiana** M.—Two at Hlawga Lake in December.

60. **Neptis jumbah jumbah** M.—One at Hlawga Lake in October and another in December.

61. **Neptis hylas adara** M.—Much the commonest *Neptis*, but they did not emerge until late September. Prior to that I saw no *Neptis* of any species.

62. **Neptis hordonia hordonia** Stoll—Fairly common.

63. **Hypolimnas misippus** (L.)—Very scarce. Only one male and a tattered female in my garden in July and another male in September.

64. **Hypolimnas bolina** (L.)—Females very common from August to October. They were very large and in fine condition. After October they disappeared. I only took two males all the time I was here and saw one other, which was missed.

65. **Precis hierta magna** Evans—Rather scarce. I cannot distinguish between this and *hierta hierta*.

66. **Precis orithiya ocyale** Hub.—Very scarce. Only three seen, all in my garden.

67. **Precis lemonias lemonias** (L.)—Very common.

68. **Precis almana almana** (L.)—Very common.

69. **Precis atlites** (Johansson)—Very common.
Note : I have seen no *Precis iphita iphita* Cr.

70. **Cupha erymantus lotis** Salz.—Very scarce. Two at Hlawga Lake in December and one in February. Another in Rangoon in December.

71. **Atella phalanta** (Drury)—Very rare here. One in Rangoon in September, another in February.

72. **Cethosia cyane** (Drury)—Common.

ERYCINIDAE

73. **Abisara echerius angulata** M.—Not uncommon at Hlawga Lake from December to February.

LYCAENIDAE

74. **Gerydus boisduvali assamensis** Doh.—Several at Hlawga Lake in October and November.

75. **Spalgis epius epius** (Wd.)—A few in my garden on gardenias, others at Hlawga Lake in December and January.

76. **Castalius rosimon rosimon** (F.)—Very common. I have seen none others of this genus.

77. **Syntarucus plinius** (F.)—One at Hlawga Lake in August, one in my garden in September.

78. **Neopithecops zalmora** (But.)—A few at Hlawga Lake in October.

79. **Chilades laius laius** Cr.—Common.

80. **Zizeeria trochilus putli** (Koll.)—A few in my garden.

81. **Zizeeria otis otis** (F.)—Very common.

82. **Euchrysops cnejus** (F.)—A few in my garden.

83. **Lycaenesthes emolus emolus** (God.)—Very common at Hlawga Lake from October to December.

84. **Lycaenesthes lycaenina lycambes** Hew.—A few in my garden from August to November ; rather scarce.

85. **Catachrysops strabo** (F.)—Very common.

86. **Lampides boeticus** (L.)—Rather scarce but a few in the garden.

87. **Jamides bochus bochus** (Cr.)—A few round Hlawga Lake from August to October and a few in the garden.

88. **Jamides celeno celeno** (Cr.)—A few in my garden.

89. **Jamides kankena pseudelphis** (But.)—Two in my garden in July and August.

90. **Jamides alecto eurysaces** Fruh.—Fairly common at Hlawga Lake from October to January.

91. **Nacaduba nora nora** Fd.—Common at Hlawga Lake.

92. **Nacaduba dubiosa sivoka** Evans—Common at Hlawga Lake.

93. **Amblypodia centaurus centaurus** F.—A few at Hlawga Lake from August to November.

94. **Surendra quercetorum quercetorum** M.—One at Hlawga Lake in September; one in February.

95. **Loxura atymnus continentalis** Fruh.—Rather scarce at Hlawga Lake.

96. **Spindasis vulcanus tavoyana** Evans—I have one specimen which may be this. It is very close to the Indian *vulcanus*.

97. **Spindasis syama peguanus** M.—Several in my garden from July to November.

98. **Spindasis lohita himalayanus** M.—A few at Hlawga Lake towards August end and in September.

99. **Spindasis gabriel** Swin.—This is a specimen which Dr. Norman doubtfully identifies as *gabriel*. It is fairly close to *S. vulcanus*.

100. **Tajuria cippus cippus** (F.)—One tattered specimen in my garden in August, and a perfect one in December; both males.

101. **Cheritra freja freja** (F.)—Common in the garden, but I have not seen it at the Lake.

102. **Hypolycaena erylus himaventus** Fruh.—Common at Hlawga Lake from August to December.

103. **Deudoryx epijarbus amatius** Fruh.—One only at Hlawga Lake in December.

104. **Rapala schistacea** M.—Four males in my garden from September to December; one female at Hlawga Lake in January.

105. **Rapala pheritimus petosiris** Hew.—Two in my garden in September.

106. **Rapala jarbas** F.—One at Hlawga Lake in February.

Hesperiidae

107. **Hasora badra badra** (Moore)—One female in my garden in October.

108. **Badamia exclamationis** (Fab.)—Fairly common.

109. **Calaenorrhinus asmara concertus** de Nicéville—One in my garden in January.

110. **Sarangesa dasahara dasahra** (Moore)—Common in my garden.

111. **Daimio bhagava bhagava** Moore—A few at Hlawga Lake January and February.

112. **Tagiades japetus ravi** Moore—Common in my garden and at Hlawga Lake from September to November.

113. **Odontoptilum angulata angulata** (Feld.)—Two at Hlawga Lake in February.

114. **Caprona agama agama** Moore—Two at Hlawga Lake in January.

115. **Astictopterus jama olivascens** Moore—Four at Hlawga Lake in September and October.

116. **Ampittia dioscorides dioscorides** (Fab.)—Common in my garden from July to December.

117. **Aeromachus** sp.—There are six specimens which I have not been able to identify, probably comprising at least two species. Dr. Norman is working on them at the moment.

118. **Halpe zema zema** Hew.—Very scarce. I have two males and four females but the latter may be females of the next species.

119. **Halpe zola zola** Evans—Only the females mentioned above.

120. **Iambrix salsala salsala** (Moore)—Very common.

121. **Udaspes folus** (Cramer)—Common at Hlawga Lake from July to October.

122. **Gangara thyrsis thyrsis** (Fab.)—A few at Hlawga Lake where I found the larva on a palm tree.

123. **Erionota thrax thrax** (Hub.)—Five, all of which flew into the house at night—August to December.

124. **Matapa aria** (Moore)—Very common in my garden.

125. **Potanthus trachala tytleri** Evans—Fairly common in my garden.

126. **Telicota colon stinga** ?—A few in my garden.

127. **Telicota ancilla bambusae** Moore—Common at Hlawga Lake and a few in the garden.

128. **Parnara guttatus** (Bremer & Grey)—Very common.

129. **Borbo cinnara** Wallace—A single one at Hlawga Lake in December.

130. **Pelopidas agna agna** Moore—Common in my garden.

131. **Caltoris cahira austini** Moore—Scarce. All from my garden.

132. **Halpe porus.** One in my garden in February.

89, MARSHALL AVENUE,
BOGNOR REGIS,
SUSSEX, ENGLAND,
March 26, 1957.

A. E. G. BEST.

11. AN EPISODE FROM THE LIFE HISTORY OF THE MOTH *SUANA CONCOLOR* WALKER

A female moth, *Suana concolor* Walk., was captured by me in the evening (about 7 p.m.) on November 21, 1956 while walking from Lodwick Point to Mahableshwar. The road in that place leads through a fairly thick shrub forest typical of the Mahableshwar plateau.

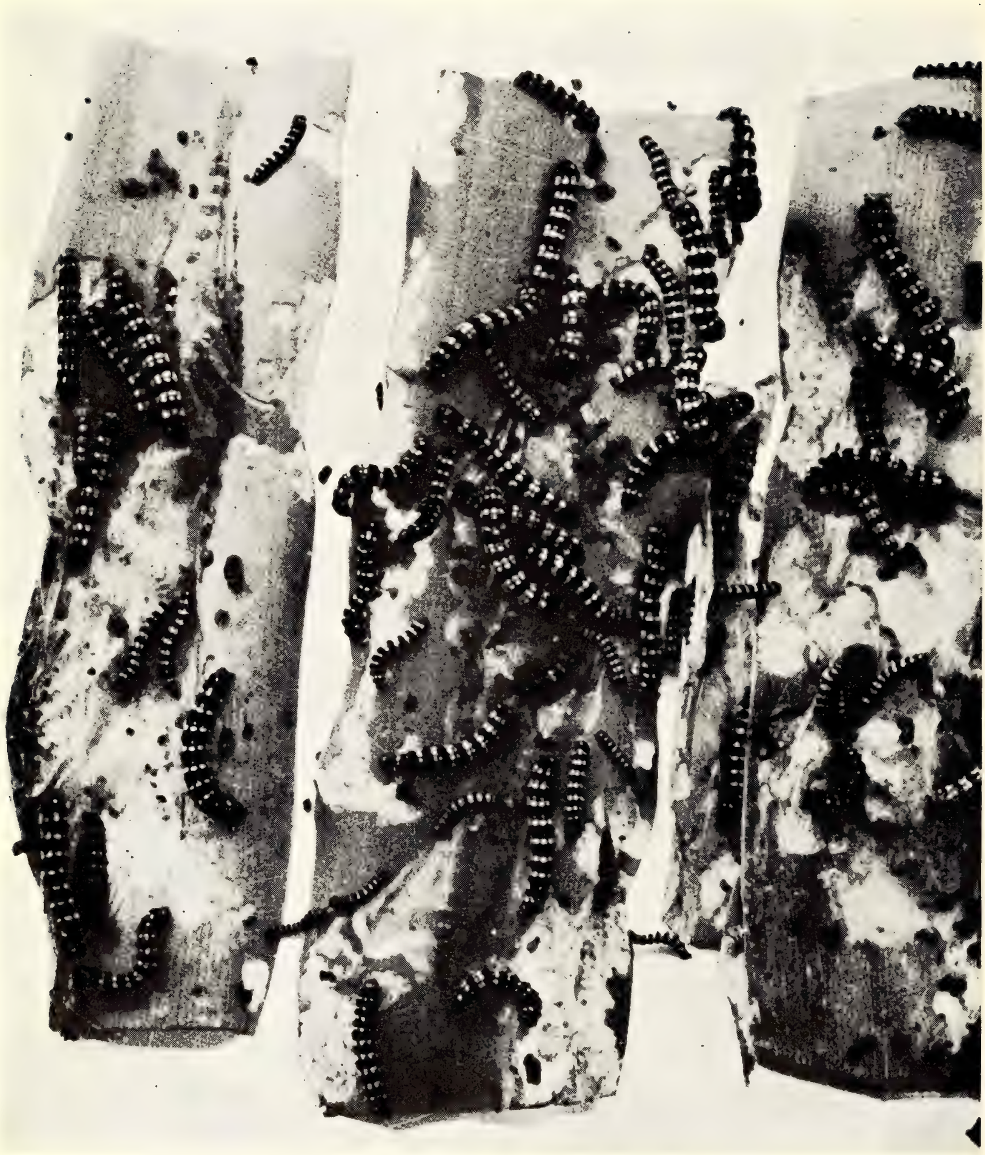
The moth was very easy to pick up as she was sitting on the ground whirling her wings rapidly but without much success. She was obviously experiencing considerable difficulty to take off in the air. I noticed that she was rather handicapped by a very big abdomen, probably full of eggs.

On arrival at my rooms I placed the moth in a cardboard box with the intention of getting next day some ether or chloroform to put her to sleep, and add this fine specimen to my collection of insects. The necessary anaesthetic was duly procured the next day, but on inspection of the box I found that the moth laid a cluster of eggs. I decided therefore to allow her to go on with this business undisturbed. The check on the quantity of eggs laid every day was being made regularly and the moth continued laying them for 5 days till my arrival back to Bombay on November 26. I found the insect dead the following day and decided to take some measurements. The results are shown below:

Wing span of the moth ...	5¼" inch
Length of the body ...	2 ,,
Weight of eggs ...	4·935 gr.
Number of eggs ...	1592
Weight of single egg ...	3·1 milligr.
Weight of the body ...	3·185 gr.
Ratio of weights eggs/body ...	1·55

The last figure is of particular interest because it demonstrates the fact that the moth is a very efficient 'flying machine' from the load-carrying capacity point of view. For comparison I have gathered below some figures in respect of more popular aircraft operating in India:

Description	Weight empty	Usual max. load	Ratio of $\frac{\text{load}}{\text{empty machine}}$
Skymaster ...	40,000 lb.	28,500 lb.	0·415
Viking ...	23,500 ,,	10,500 ,,	0·45
Dakota ...	17,000 ,,	9,200 ,,	0·545
Constellation ...	60,000 ,,	47,000 ,,	0·68
Super-Constellation ...	72,000 ,,	63,000 ,,	0·88



Larvae of the Lily Moth *Brithys crini* Fabricius feeding on the leaves of *Crinum latifolium.*

Photo : Nawab H. Khan

Thus the moth, proportionately to her own weight, is able to carry almost a double load as compared with the Super-Constellation.

The eggs were brown in colour with a yellow patch and of a shape resembling a duck's egg, but somewhat broader at the end, size 0.083″ × 0.050″. After counting and taking the measurements I left them in a box placed in a drawer. On December 7, i.e. approximately 14-16 days from the date of laying, the caterpillars began to hatch. First the head would appear and then the caterpillar would start eating larger hole in the shell to provide sufficient opening. Then slowly the whole body would wriggle out. The whole operation from the instant of first crack in the shell lasted on the average 40 seconds.

The caterpillars were about $\frac{1}{4}$ in. long (body only) with tufts of long hair on the head, tail, and sides, and a black head. The hair was at first greyish but within one hour or so would darken to black.

The first action of caterpillars after emerging from the egg was to eat the egg shell. The internal texture of the shell was bluish and shining like mother-of-pearl.

I tried, unsuccessfully, all sorts of leaves from the trees, shrubs, and other plants, but the caterpillars would not eat anything but their own egg shells. If disturbed, they descended to the ground using a spider-like thread secreted from the body and fastened to the leaf at one end. I have not seen them returning by means of the thread.

As all attempts to feed the caterpillars eventually failed I let them loose in the garden.

National Electrical Industries Ltd.,
Industrial Estate,
Bombay 12,
March 4, 1957.

S. SZAFRANSKI

12. NOTES ON THE BIOLOGY AND CONTROL OF THE LILY MOTH *BRITHYS CRINI* FABRICIUS

(*With a plate*)

INTRODUCTION

Of all the pests attacking lily plants in India, the moth *Brithys crini* Fabricius (Phalaenidae, Lepidoptera) is probably the most serious one. The larvae are commonly found feeding on the leaves and bulbs of *Crinum latifolium* and *C. asiaticum* from August to November. Often the attack is so severe that an entire plant is eaten up within two or three days of the initial attack. But in spite of all its importance as a pest of ornamental plants, practically no effort has been made to study its biology and methods of control. In fact, the pest has not even been mentioned in the volumes on moths in the FAUNA OF BRITISH INDIA series. It seems that at present, when the pest is causing great damage to lilies, a detailed study of its bionomics and control is absolutely essential. The present work is a preliminary attempt in this direction.

Eggs:

The eggs are deposited on the leaves of the lily plants and can be easily recognized by their colour. When freshly laid they are bright yellow in colour, but within the next 24 hours turn brown. By the fifth day the colour changes to grey and on the sixth day the eggs become whitish with black tips revealing the presence of the enclosed embryos.

The number of eggs varies greatly with different batches. Of the various batches examined it varied from 4 to 67 eggs with an average of 33.9 eggs per batch. Nearly all the eggs of a batch hatch at the same time and the incubation period occupies 7 to 8 days under laboratory conditions.

Larvae:

The larvae of *Brithys crini* have well developed prolegs and can be easily recognized by their strongly transverse spinneret and mandibles having three sharp distal teeth and two small angulations (Gardner, 1941 & 1947). During the present studies, 150 newly hatched larvae were reared individually in glass vials. Each larva was placed on a piece of lily leaf by means of a camel-hair brush. The vials were covered by cheese-cloth to prevent the larvae from escaping. The larvae were examined at 24-hour intervals for removing excrements, observing moults, and providing fresh food.

Mortality was exceedingly high in the first instar; 137 larvae died in this stage. Of the remaining 13 larvae, 2 escaped by cutting holes through the cheese-cloth covers while in the fifth instar. This necessitated the replacement of cloth covers by wire gauze coverings. 4 of the remaining larvae died during the course of development and only 7 pupated.

There are 7 larval instars in the case of *Brithys crini* and the total larval period occupies 31.28 days. There is, however, a great variation in the duration of the seventh instar. While no definite explanation can be given for this discrepancy, it is possible that some moult has been missed between the sixth and the seventh instars, though the authors are very doubtful about this, as all the larvae were carefully examined each day during the course of their development.

Pupae:

Freshly formed pupae were placed separately on cotton pads in glass dishes. The duration of the pupal period varied from 6 to 8 days with an average of 6.68 days. This means that the entire life-cycle from egg to adult stage is completed in 45.26 days under laboratory conditions with a mean temperature of 85.9°F. and 78.8% relative humidity.

Adults:

18 newly emerged females were placed individually with males on leaves of lily plants. Each pair was confined to a leaf by tying a cellophane paper bag around the leaf.

No mating could be observed. The pre-oviposition period varied between 1 to 3 days and the females readily oviposited under laboratory conditions. It seems that the females have no specific choice for oviposition sites for they very often deposited their eggs on the walls of the glass tubes and cloth coverings. A single female may lay several batches of eggs. During the present studies a maximum of 3 batches was laid per female and the maximum number of eggs laid by a female was 138, the minimum 5.

In common with many insects the males are short lived as compared to females, the longevity being 2.16 days in the case of males and 3.31 days in females. There was also an indication that males are much rarer than the females in the case of *Brithys crini*.

CONTROL

A study of the life-cycle of *Brithys crini* indicates that it is in the larval stage that the pest can be successfully controlled. As the larvae feed for a considerable time by boring in the leaf tissues, they can be easily killed by some effective chemical having the power of penetrating the leaf tissues. During the present studies, three concentrations of DDT, DDD, and Lindane (99% Gamma Benzene hexachloride) emulsions were tried against the larvae. The various dilutions in water were prepared from 25% stock emulsions of DDT and DDD and a 20% Lindane emulsion.

10-inch portions of leaves were thoroughly sprayed with the desired insecticidal solutions and a randomized lot of 50 larvae was confined to each treated leaf by tying a cellophane bag around it. 3 tests were performed with each concentration and two kinds of checks were used. In the first check the larvae were placed on leaves previously sprayed with water alone, while in the second case a randomized lot of larvae was bagged on an untreated leaf. The results obtained are presented in table 1.

TABLE 1. EFFICIENCY OF DDT, DDD, AND LINDANE AGAINST *Brithys crini*

Concentration used	% Control with :		
	DDT	DDD	LINDANE
1 : 8 ...	50·0	30·0	71·4
1 : 16 ...	18·1	14·3	53·8
1 : 24 ...	11·1	20·3	38·4
Check (H_2O) ...	0·0	0·0	0·0
Check (untreated leaves) ...	0·0	0·0	0·0

Of all the insecticides tested, Lindane gave the best results and as this material did not produce any injury on the leaves it can be recommended for the control of *Brithys crini*. Still better results would probably be obtained by using Lindane dust for, in a preliminary experiment in which leaves of several lily plants were dusted with 0.65% Lindane, 75% of the attacking larvae died.

SUMMARY

The present paper is a preliminary attempt to study the biology and find out some effective chemicals for the control of *Brithys crini*, a serious pest of lilies in India. The results obtained show: (i) The life-cycle from eggs to adult stage is completed in 45.26 days under laboratory conditions with a mean temperature of 85.9°F. and 78.8% relative humidity. (ii) Males are short-lived and much rarer in nature than the females. (iii) Satisfactory control of the pest can be obtained by spraying the lily plants with 1 : 8 water dilution of 20% Lindane emulsion. Still better results can be obtained with 0.65% Lindane dusted on lily plants.

ACKNOWLEDGEMENT

The authors wish to express their sincerest gratitude to Professor M. B. Mirza, Head of the Zoology Department, for his valuable advice during the progress of this work.

DEPARTMENT OF ZOOLOGY,
MUSLIM UNIVERSITY,
ALIGARH,
September 15, 1956.

NAWAB H. KHAN, Ph.D.
ZILLE HASAN ABEDI, M.Sc.

REFERENCES

Gardner, J.C.M. (1941): Immature stages of Indian Lepidoptera (2) Noctuidae, Hypsidae. *Indian For. Rec.* **6**, (8).

Gardner, J. C. M. (1947): On the larvae of the Noctuidae III. *Trans. R. Ent. Soc., Lond.* **98** (4): 59-90.

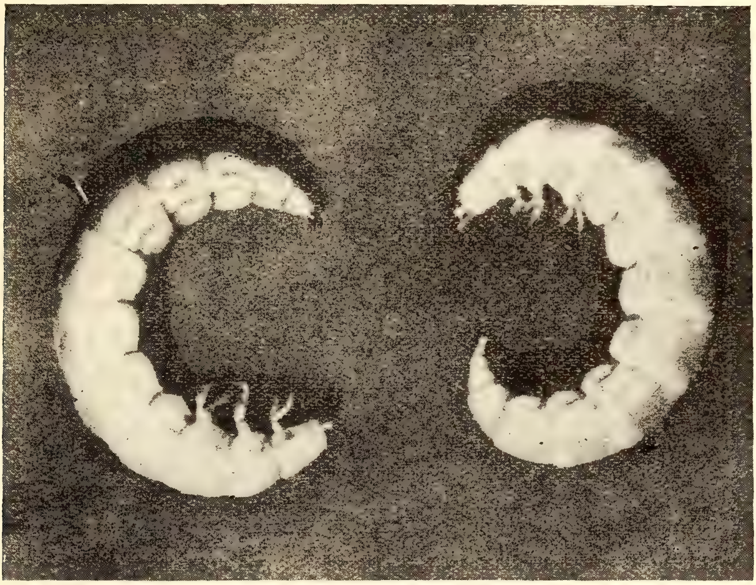
13. AN UNDESCRIBED LUMINOUS BEETLE LARVA FROM SOUTH INDIA

(*With one photograph*)

Various stages of the present larva were collected by the author during the last several years mostly from dry areas in South India. As all attempts to rear them to the adult condition failed, their identification proved difficult. Recently the discovery of the exactly similar caustic odour so characteristic of the larva in some winged adults collected from the same locality helped considerably in identifying them as *Rhagophthalmus* sp. (Rhagophthalmidae, Coleoptera). Lefroy (1909) has recorded two species of the adult beetles, but the larval forms have not so far been described.

The present larva differs from all the Indian luminous beetle larvae described so far (Raj, J. S., 1943, 1944, 1947, 1952, and Gardner, 1946) in the complete absence of epicranial suture, in the much less extensive antacorial membrane of the antenna, in the imaginal type of mandible without a retinaculum and a basal brush, in having an additional abdominal segment and in having a different type of distribution of the photogenic organs.

The distribution of the photogenic organs in the larva is extremely interesting and differs from the types figured by Buck (1948). While the winged adults appear to be non-luminous, the larva combines the winged imaginal type of photogenic organ as well as the larval type of the Indian Lampyrid larvae. The number and disposition of these light organs, while having considerable taxonomic significance, bring up many questions pertaining to the relationships and phylogeny of the Lampyridae and the Rhagophthalmidae. Again, as in the Phengodid larva, there are eleven pairs of minute segmentally arranged luminous spots on the thorax and the abdomen. Detailed work on the anatomy and physiology of these larvae is in progress.



Larvae of *Rhagophthalmus* sp.

My thanks are due to Dr. F. I. Van Emden for identifying the larva and to Dr. Alagappa Chettiar Educational Trust for the facilities given.

DEPT. OF ZOOLOGY,
ALAGAPPA COLLEGE,
KARAIKUDI,
May 10, 1957.

J. SAMUEL RAJ

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Lefroy (1909) : 'Indian Insect life' : 327.
Raj, J. S. (1943) : *Curr. Sci.*, **3** : 83-84.
— — — (1943) : *Curr. Sci.*, **6** : 186-87.
— — — (1943) : *Curr. Sci.*, **10** : 270-73.
— — — (1944) : *Curr. Sci.*, **4** : 106-107.
— — — (1947) : *Proc. Ind. Acad. Sci.*, **25** : 188-194.
— — — (1952) : *Curr. Sci.*, **8** : 222.
Gardner, J. C. M. (1946) : *Ind. Journ. Ent.* **8** : 121-129.
Buck, J. B. (1948) : *Ann. N. Y. Acad. Sci.* **49** : 472.

14. TWO NEW SPECIES OF *PRIOCHIRUS* (STAPHYLINIDAE: COLEOPTERA) FROM INDIA

(*With two text figures*)

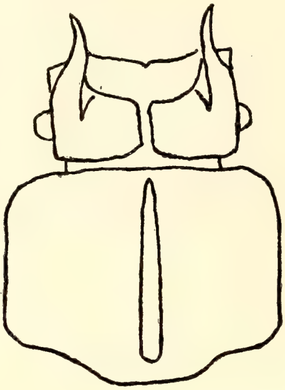
The Bombay Natural History Society was so kind as to entrust me with the determination of their collection of Indian Staphylinidae. I ascertained in this material two new species of *Priochirus* (sub-genus *Plastus*) which are described below.

Priochirus (Plastus) astoliensis sp. nov.

Black, shining, the edge of the 4th visible abdominal segment red. Femora dark, tibiae reddish brown, tarsi red. Antennae black, the last joint reddish. Length 8.5 mm.

Holotype and 11 Cotypes: India, Astoli, North Kanara. Collected on April 21, 1914 by Mr. T. R. Bell.

For the shape of the head and thorax see fig. 1.



1.

Text-fig. 1. The head and thorax of *Priochirus* (*Plastus*) *astoliensis* sp. nov.

Frontal impression very broad, very indistinctly grooved in the middle, its front border very feebly emarginate in the middle. The lateral horns long, outwards rounded, and very advanced. There is on each side of the vertex an impression making the frontal horns apparently still more advanced. Vertex sulcate. Antennae with the 6th to 10th joints transverse. Thorax distinctly transverse, medially sulcate, the reflexed sides with several moderately large punctures and at the base with a few more. Elytra a little longer than the thorax, longer than broad heavily longitudinally impressed on the disc near the sutura. Abdomen finely, superficially punctured at the bases of the segments. The 4th visible tergit with several greater punctures on its whole surface.

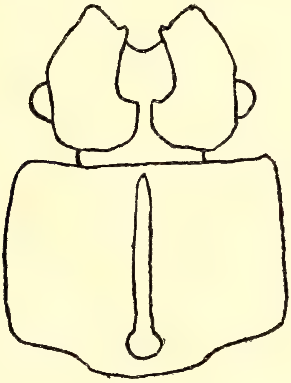
Holotype and 7 Cotypes in the collection of the Bombay Natural History Society, 4 Cotypes in my own collection.

Priochirus (Plastus) maitrta sp. nov.

Subconvex, black, shining, the apex of the abdomen red. Femora and tibiae reddish, tarsi reddish—testaceous. Antennae brown. Length 5 mm.

Holotype and 5 Cotypes: India, Basti Karwar. Collected on June 28, 1907 by Mr. T. R. Bell.

For the shape of the head and thorax see fig. 2.



2.

Text-fig. 2. Head and thorax of *Priochirus* (*Plastus*) *maitrta* sp. nov.

Frontal impression longer than broad, its side margins forming an apparent chalice together with the inner margins of the frontal horns and with the sulcation of the vertex. The frontal horns short, extremely blunt and stout, parallel, on each inner side a small denticle near the middle, vertex sulcate and provided with a few punctures. Antennae with the 5th to 10th joints transverse. Thorax strongly transverse, a little narrowed in front, the sides and the base with several rather large points, deeply sulcate. The sulcation longitudinal, forming a ball near the base. Elytra a little longer than broad, as broad as the thorax and longitudinally impressed. Abdomen rather coarsely punctured at the sides of the segments.

I give to this new remarkable species the Hindi name of friendship to symbolize the friendly collaboration of Indian and Czechoslovakian entomologists.

Holotype and 3 Cotypes in the collection of the Bombay Natural History Society, 2 Cotypes in my own collection.

PRAHA,
CZECHOSLOVAKIA,
March 28, 1957.

RUDOLF DVORAK

15. THE SWARMING TERMITES OF DELHI

Pruthi (1939) reported from Delhi the emergence of three species of winged termites, *Odontotermes* sp., *Microtermes* sp., and a third unidentified. These termites according to him appeared respectively about the second, third, and fourth week of the month of July 1938. The present author has noticed during the past few years that there are some other species of termites also which swarm at Delhi. Yearly collections of the winged termites were started in the Department of Zoology, University of Delhi, since 1956. A light-trap was used for this purpose, and the collection was initially restricted to the Delhi University area which is fairly heavily infested by termites. The collection work is planned also to be extended to the other localities of the city and suburbs of Delhi in the subequent years.

The swarming period of the termites locally lasts for nearly one and a half months, usually commencing from the third week of June up to the first or second week of August marked by the onset of rainy season. Almost all the termites so far observed appear after sunset, and are strongly attracted towards light. Only one species *Eremotermes paradoxalis* Holmgren was found to fly during daytime on certain occasions in the years 1954 and 1955, but this invariably happened when the sky was thickly clouded and there was a breeze.

The light-trap used for collection consists essentially of a large smooth tubeless 'funnel' (1 ft. wide at the top with 1½ in. wide aperture at the bottom) made of galvanized tin, but art-paper also served well for temporary use. The funnel was firmly fixed on a stand, and below that was arranged a cylindrical jar half-filled by rectified spirit. A strong electric light of 200 watts was suspended from the shade so as to be on the top of the funnel. This apparatus used to be kept in the open ground and worked satisfactorily even during the rain. The light was kept on from sunset to the next morning. Such a light-trap attracted a large variety of insects, which falling on the smooth surface of the funnel slip down into the collecting jar. Often along with other insects there would be hundreds of winged termites (one or more species at the same time) in a single collection. The insects were removed from the jar on the next day and sorted out. The termites obtained in this manner were complete specimens, all with wings intact. The specimens were kindly identified by Mr. W. V. Harris of the British Museum (Natural History).

Observations:

In the last swarming season (1956) the following seven species of alate termites were obtained from the Delhi University campus.

KALOTERMITIDAE:
Kalotermes beesoni Gardner

RHINOTERMITIDAE:
Coptotermes heimi (Wasmann)

TERMITIDAE:

Eremotermes paradoxalis Holmgren
Odontotermes dehraduni (Snyder)
Odontotermes sp.
Microtermes mycophagus (Desneux)
Microtermes sp.

The swarming period of termites in Delhi lasted for a little more than a month. Of the seven species collected, *Microtermes mycophagus*, *Eremotermes paradoxalis*, and *Coptotermes heimi* had the most frequent and thickest appearance in swarms; *Odontotermes dehraduni*, and other two unidentified species of *Odontotermes* and *Microtermes* appeared sporadically in very small numbers; *Kalotermes beesoni* was represented in an extremely small number and that too only at the commencement of the swarming season. These observations seem to be in correlation with the incidence of infestation by these species of termites in the collection locality. The termites of the first group have maximum infestation in the University campus, those of the second group also occur but less abundantly, while no infestation of *K. beesoni* has been noticed so far, probably as the winged specimens of this species are brought in from farther places by wind.

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF DELHI, H. S. VISHNOI
DELHI-8,
May 14, 1957.

REFERENCE

Pruthi, H. S. (1939): Emergence of winged termites of Delhi. *Indian J. Ent.* **1** (1-2): 108.

16. ON THE HARPACTICOID COPEPOD *PHYLLOGNATHOPUS VIGUIERI* (MAUPAS)

(*With one plate*)

Our knowledge of the freshwater harpacticoid copepods of India is limited to the work of Chappuis (1928, 1941, 1950, and 1954) who has described the forms collected in various parts of India. A single female of *Phyllognathopus viguieri* (Maupas) was recorded by him from the foot of a waterfall at Courtalam in south India. Recently a small collection of freshwater copepods was sent to the author for determination by the water analyst to the Corporation of Madras. This collection made in the underground water mains was composed of *Phyllognathopus viguieri* (Manpas), adults and in various stages of development. Since this is a very variable species with a wide distribution, it was felt that a brief description of the forms collected at Madras, which show some distinct features, will be of interest.

Phyllognathopus viguieri (Maupas) Fig. 1-13.

Gurney, R. *Brit. Freshwater Copepoda*, **2**, pp. 8-15, Figs. 345-372 (1932).
Lang, K. *Monographie der Harpacticiden*, pp. 268-270, Fig. 137, (1948).

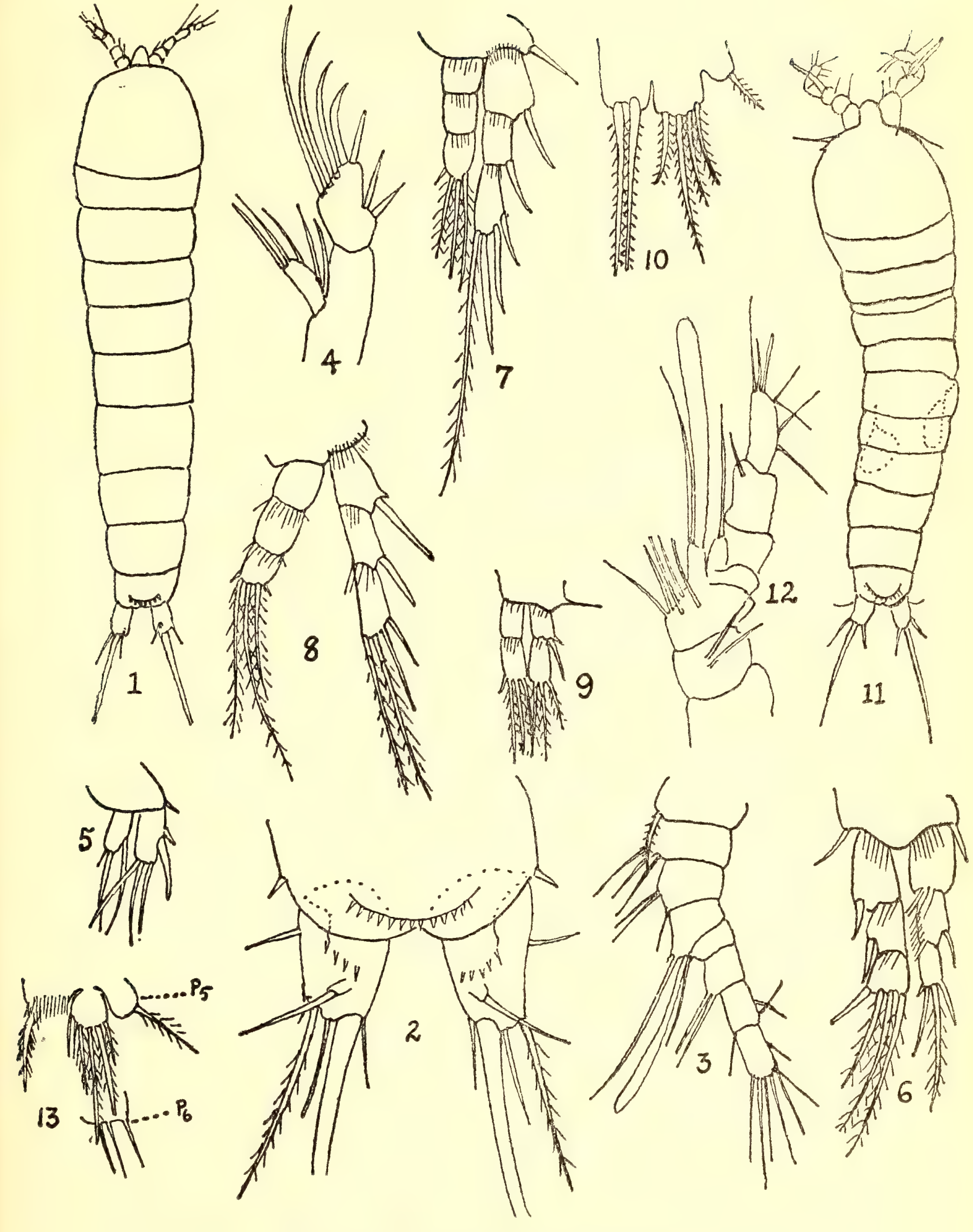
FEMALE:

Measures 0.51 mm. long. Body is small and slender. The cephalasome is free and is nearly twice as long as the succeeding segments. The caudal ramus is nearly twice as long as broad and bears a stout inner, a short plumose outer, and two outer and two apical slender setae. There is a small row of fine spinules on the upper side. The anal operculm is fringed with fine spinules (fig. 2). The antennule (fig. 3) is composed of eight segments, the first one carrying an outer plumose seta and agreeing with the description given by Gurney (1932, fig. 353). The antenna (fig. 4) is composed of four segments, the second segment carrying an unsegmented exopod, which carries five setae. The terminal joint of the endopod bears seven setae. The mandible and other mouth parts agree closely with the description given by Gurney (loc. cit.). The outer branch of the mandible palp (fig. 5) is, however, devoid of the two lateral setae shown by him. The rami of the first three pairs of legs are three-jointed and all of them are clothed with very fine setae. The basal$_2$ of the first leg (fig. 6) has an inner spine as well as an outer seta. The first and the second joints of the exopod carry an outer spine each, while the terminal segment has an outer spine and three apical setae. The endopod is as long as the exopod and its second joint carries an inner seta and the terminal joint three apical setae. In the second leg (fig. 7), the exopod is slightly longer than the endopod and the innermost seta on the exopod is very long. The structure of the third leg (fig. 8) resembles that of the second one. The fourth leg (fig. 9) is very small and both the rami are two-segmented. In all the descriptions of this species so far given, the exopod of fourth leg is stated to be three-jointed except in a male described by Chappuis (*vide* Lang, 1948, fig. 137 6 *b*) where both the rami are shown as two-jointed. This two-jointed nature of the fourth leg is therefore of interest. In the fifth leg (fig 10) the inner expansion and the distal segments are fused. The basal segment has an outer and two inner plumose setae while the distal joint carries four setae.

MALE:

Resembles the female in general shape (fig. 11) but is slightly smaller in size measuring 0.50 mm. only. The antennule (fig. 12) is geniculate, the hinge lying between the sixth and the seventh joints. The antenna, mouth parts, as well as the first four pairs of appendages as in the female. Gurney (1932) as well as Chappuis (1916) found some differences in the second, third, and fourth legs of the male, but this is absent in the Madras form. In the fifth leg (fig. 13) the basal expansion and the distal joints are indistinctly divided. The basal expansion has an outer seta and a stout plumose spine on the inner side. The distal joint is small and has four plumose and two ordinary setae.

The presence of the vibratile organ in the lateral corner of the cephalasome is a peculiar feature, the function of which is not known. Chappuis (1914) has given a detailed account of the structure of this.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Phyllognathopus viguieri (Maupas)
Explanation of figures in text.

REMARKS

Since this genus shows a number of unique features, such as the separation of the somite of the first leg, the large biramus mandible palp, and the primitive structure of the maxilla, Gurney (1928, 32) proposed a new family Phyllognathopodidae for the inclusion of this genus. Lang (1948) in his monograph places this family in the super family Neobradyidimorpha in which are included Neobradyidae, D'arcythompsoniidae, and Chappuisiidae. This along with the super families like Cerviniidimorpha, Ectinosomidiimorpha, and Neobradyidimorpha form the sub-section Maxillipedasphalea under the section Oligarthra.

The different species and varieties of *Phyllognathopus* so far described have been considered as a single but widely variable species by Lang (loc. cit.). The Madras form differs from all the others in the possession of two-jointed rami in the fourth leg and in certain minor differences in the setation of the mandible palp and legs. But these differences do not seem to justify the creation of a new species.

DISTRIBUTION

Maupas described this species from the decayed banana tree in Algiers in 1892. Since then it has been recorded from: the British Is. (Scourfield, Gurney, Lowndes), Germany (Hartwig, Klie, Kieffer, Kessler, Zigelmayer, Noodt), Czechoslovakia (Mrazek), Austria (Spandl), Poland (Jakubisiak), Russia (Borutzky), Switzerland (Chappuis, Schmitter), Italy (Kessler, Chappuis), Algiers (Maupas), Tanganyika Lake (Gurney), Sumatra (Chappuis), Java (Chappuis, Menzel), Aru Archipelago (Menzel), U.S.A. (Chappuis), South America (Chappuis), Courtalam, south India (Chappuis), Madras (present record).

ECOLOGICAL NOTES

This copepod has been found usually in the water collected in the leaf axils of Bromeliaceous plants. Lowndes (1932) found them in pineapples brought into London. It has also been found in a coal mine in Germany, in a gutter in Vienna, in underground water, in freshwater springs and lakes, and in filter beds. Hence the present record from the water mains at Madras is of interest.

The water in which the specimens were kept in a glass vessel contained much organic detritus and the pH was 5.5. The copepods were quite active. They were able to swim about even when there was only very little water, just sufficient to cover the body. They usually move about even on the surface film of the water.

The life-history of this copepod has been worked out by Maupas (1892) and Chappuis (1916).

The author wishes to express his grateful thanks to Mr. M. G. Devadoss, B.SC., Water Analyst, Water Works Department of the Corporation of Madras for the gift of the material.

ZOOLOGY RESEARCH LABORATORY,
UNIVERSITY OF MADRAS,
MADRAS-5,
February 15, 1957.

S. KRISHNASWAMY

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17. A NOTE ON THE NEMATODE *MERMIS INDICA* V. LINSTOW PARASITISING INSECTS

Amsacta moorei Butler of form *sara* and *Cirphis* sp. are serious pests of maize and other *Kharif* crops in Jhabua district of Madhya Pradesh. In the course of investigations on them we came across a Nematode, *Mermis indica* v. Linstow (Ascaroidea: Mermithidae), parasitising the caterpillars of the two. This Mermithid was found to have emerged from an adult male *A. moorei* of the form *sara*. The parasite larva grows inside the body-cavity of the caterpillar at the expense of its body-fluids. When full-fed, it comes out of the host's body through almost any point. Generally only one or two of these nematodes are found in each parasitised caterpillar, although 23 were counted in one caterpillar. The percentage of parasitised caterpillars in one village was as high as 66. The nematodes recovered from dead or dying caterpillars measure from 3.6 to 20.4 cm. in length. It is interesting to see such long nematodes in host caterpillars attaining only 4-5 cm. in length when full-grown. Details about this parasite will be published elsewhere.

AGRI. RES. INST.,
GWALIOR,
March 11, 1957.

O. S. BINDRA
S. U. KITTUR

18. A NEW VARIETY OF *GYMNOSPORIA FALCONERI* LAWSON FROM NORTHERN OUDH, UTTAR PRADESH

In connection with the revision of his FOREST FLORA FOR PILIBHIT, OUDH, GORAKHPUR, AND BUNDELKHAND Mr. P. C. Kanjilal, I.F.S. (Retd.), while recently working in the Dehra Dun Herbarium drew my attention to certain specimens collected from Tulsipur, Gonda, by Sri Ram (P.C. Kanjilal's collector) on 6th April 1918, which did not match with the specimens of typical *Gymnosporia falconeri* Lawson. A scrutiny and close examination of these specimens and comparison with other specimens of *G. falconeri* in the herbarium revealed that they differ from typical *G. falconeri* in several respects and in fact exactly match a sheet collected by Inayat (No. 23587) as early as 1900 from Bahu Sahi, Sota, Nepal, a locality just a few miles to the north, on the other side of Gonda district. The specimens have, therefore, been named as *Gymnosporia falconeri* Laws. var. *kanjilalii* Raizada var. nov. This variety differs from typical *G. falconeri* Laws. in having glabrous leaves, smooth on both surfaces, and longer and larger fruit (9 mm.-14 mm. long).

Gymnosporia falconeri Laws. var. *kanjilalii* Raizada var. nov.—Folia glabra in utraque pagina ad maturitatem; fructus maiores atque longiores (9 mm.-14 mm. longi). Typus lectus ab Inayat in loco Bahu Sahi, in Sota, Nepal, et positus in herbario Forest Res. Inst. ad Dehra Dun sub numero Inayat 23,587.

I am grateful to Rev. Father H. Santapau of St. Xavier's College, Bombay, for the Latin diagnosis of the new variety.

FOREST RESEARCH INSTITUTE,
DEHRA DUN,
February 26, 1957.

M. B. RAIZADA

19. *DOLICHOS BRACTEATUS* BAKER: CLARIFICATION OF NOMENCLATURE

Santapau and Panthaki (1956) have published a note about the correct nomenclature of *Dolichos bracteatus* Baker. They have concluded that *Dolichos bracteatus* Baker is an illegitimate name, because of the existence of an earlier homonym, i.e. *Dolichos bracteatus* Wall. Hence they have given the taxon a new name, i.e. *Dolichos ghaticus* Santapau and Panthaki.

However the above deduction is not correct, because *Dolichos bracteatus* Wall. has never been validly published. The new names published in Wallich Catalogue are not validly published, because they are not accompanied by the descriptions of the taxa, which is necessary for valid publication according to Art. 32 which runs as follows: 'In order to be validly published, a name of a taxon of recent plants must be both (1) effectively published (see Art. 29) and (2) accompanied by a description of the taxon or by a reference (direct or indirect) to a previously and effectively published description of it.' Hence the new names listed in Wallich Catalogue are only *nomina nuda* which have no nomenclatural standing. For further discussion on *nomina nuda* one is referred to Ross (1956).

Baker (1876, p. 225) has mentioned *Dolichos bracteatus* Wall. as a synonym of *Rhynchosia bracteata* Bentham ex Baker. This also does not validate the publication of *Dolichos bracteatus* Wall. (*vide* Art. 37).

Thus it is clear that *Dolichos bracteatus* Wall. has no nomenclatural status. It is not correct to regard it the basionym of *Rhynchosia bracteata* Benth. ex Baker, as stated by Santapau and Panthaki (1956).

Baker has attributed this name to Bentham, hence *Rhynchosia bracteata* Benth. ex Baker is to be treated as a species quite independent of *Dolichos bracteatus* Wall. The type of *Rhynchosia bracteata* Benth. ex Baker is not necessarily Wall. 5,554. As Baker has not specified the type specimen, an author may choose a lectotype out of the specimens cited by Baker (1876).

Hence the correct name of the taxon under discussion is *Dolichos bracteatus* Baker in Hooker f. Fl. Brit. Ind. 2 : 210 (1876) Synonym : *Dolichos ghaticus* Santapau and Panthaki, *J. Bom. Nat. Hist. Soc.* 53 (3) : 502, 1956.

C/O THE HERBARIUM,
ROYAL BOTANICAL GARDENS,
KEW, RICHMOND, (SURREY),
ENGLAND,
March 28, 1957.

S. I. ALI

LITERATURE CITED

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Santapau, H. & Panthaki, D, (1956) : *Dolichos bracteatus* Baker, *JBNHS* 53 (3) : 501-502.

20. *IPOMOEA TROPICA*, NEW NAME FOR A COMMON BOMBAY PLANT

C. B. Clarke, in Fl. Brit. Ind. 4: 201, 1883, describes a plant, *Ipomoea calycina*, which he attributes to Bentham (Gen. Plant. 2: 872); Cooke in Fl. Pres. Bombay 2: 242, 1905 and Santapau in this Journal (47: 346, 1948) merely mention *Ipomea calycina* Clarke. The question of the attribution of the specific name has been settled by the third paragraph of Art. 42 of the International Code of Botanical Nomenclature.

This species is native of tropical Africa, according to *Index Kewensis*; but it is well established in various parts of India; it has been recorded from the western Himalayas (Royle), Banda (Edgeworth), south India (Gamble), and various parts of Bombay State such as Gujerat, Saurashtra, Poona, Baroda, Dangs Forest, and in the neighbourhood of Bombay City. It is a hedge plant, flowering and fruiting in fairly great profusion in October-November. The plant is easily distinguished from all other species of the genus by the shape of its sepals and corolla.

The name of the plant, however, requires correction. Meissner in Martius' Fl. Bras. 7: 260, t. 97, 1869, described another plant under the same name, and in accordance with the provisions of the Intern. Code of Bot. Nom. (Articles 73_3 and 74) our Indian plant cannot bear the name *I. calycina*, it being a later homonym of that of Meissner's. We propose the name:

Ipomoea tropica Sant. & Patel, nom. nov.

Convolvulus calycinus Roxb. Hort. Beng. 13, 1814, nom. nud., & Fl. Ind. 1: 471, 1832.

Aniseia calycina Choisy, Conv. Or. in Mem. Soc. Phys. Hist. Nat. Genève 6: 482, 1833; Wight, Ill. t. 168*b*, f. 5, & Icon. t. 833; Dalz. & Gibs. Bombay Fl. 163.

Ipomoea calycina Clarke in Hook. f. Fl. Brit. Ind. 4: 201, 1883; Cooke, Fl. Pres. Bombay 2: 242, 1905; Gamble, Fl. Pres. Madras 911, 1923; Santapau in *JBNHS*, 47: 346, 1948 (non Meissn. 1869).

ST. XAVIER'S COLLEGE,
BOMBAY 1,
February 11, 1957.

H. SANTAPAU, S.J., F.N.I.
V. PATEL, B.SC. (Miss)

21. A NEW SPECIES OF *GLEADOVIA* GAMBLE ET PRAIN FROM MANIPUR

(*With a plate*)

While exploring the flora of Manipur, the author collected some specimens of *Gleadovia* Gamble et Prain, which on subsequent and thorough examination turned out to be a new species.

Gleadovia banerjiana sp. nov.

Relationship: This species comes very near to *Gleadovia kwangtungense* Hu (Sunyatsennia 4: 7, 1939) from which it differs in (i) bracteoles not being tomentose, (ii) form of the calyx, and (iii) hairyness of the corolla.

Small leafless herb; parasitic on subterranean roots of *Strobilanthes discolor* T. Anders; *Stem* fleshy, up to 1 cm. long, 3 mm. diameter. *Inflorescence* 1-3-flowered, cymose, lateral flowers do not develop. *Flowers* large, subsessile, 5-7.5 cm. long, about 1.5 cm. in diameter, fleshy, hermaphrodite, hypogynous, gamopetalous, shortly pedicellate, bracteolate, protandrous. Bracteoles 12 in number, spirally arranged, lanceolate or ovate-lanceolate, spathulate, adnate at the base, smooth, broad, obtuse or emarginate at the apex, varying in size, 4 from the base, 3-6-veined, 0.4-0.7 × 0.3-0.5 cm.; 5th and 6th 15-18-veined, 1.8 × 1 cm.; 7th and 8th, 22-25-veined, 2.0-2.5 × 1.2-1.5 cm.; 9th and 10th 27-30-veined, 2.5-3.0 × 2.0-2.2 cm.; 11th and 12th 30-32-veined, 3.0-3.2 × 2.2-2.5 cm. *Calyx* gamosepalous, spathaceous, irregularly 5-lobed at the tip, split in nearly ⅓ of its length, 3.5-5 × 3.0-4.5 cm.; veins 52, parallel. *Corolla* gamopetalous, white, rose tinged or light yellow, fleshy, 3.5-5.5 × 3-4.5 cm., veins 33-35; corolla tube broad, slightly incurved, dilated at the throat, limb obscurely 2-lipped, lobes 5, erect, spreading, subequal, obtuse, imbricate with downy moniliform trichomes, which are 2-2.5 mm., 10-15-celled. *Stamens* 4, epipetalous, adherent up to 0.8 cm. in length, inserted, didynamous; filaments stout, longer ones 0.4 cm. long, shorter ones 0.25 cm. long. *Anthers* attenuated, adnate, 2-lobed, both the cells perfect, longitudinal, base of the anther cells not mucronate, slightly divaricate, connectives produced. Pollen grains round smooth with thin exine. *Disc* annular, dull white, 1.5 mm. high. *Gynoecium* syncarpous; stigma 2 mm. incurved capitate, 2-lobed, tumid, style stout, 8 mm. glabrous; *ovary* ovoid glabrous, superior 8 × 8 mm., one-celled with 4 dichotomously branched parietal placentas, ovuliferous all over.

Manipur, Koupru Hill, 6,000 ft., total parasite on the roots of *Strobilanthes discolor* T. Anders.; flowers white tinged with rose or light yellow, D.B. Deb no. 2247 A (Flora of Manipur) 11th April, 1954.

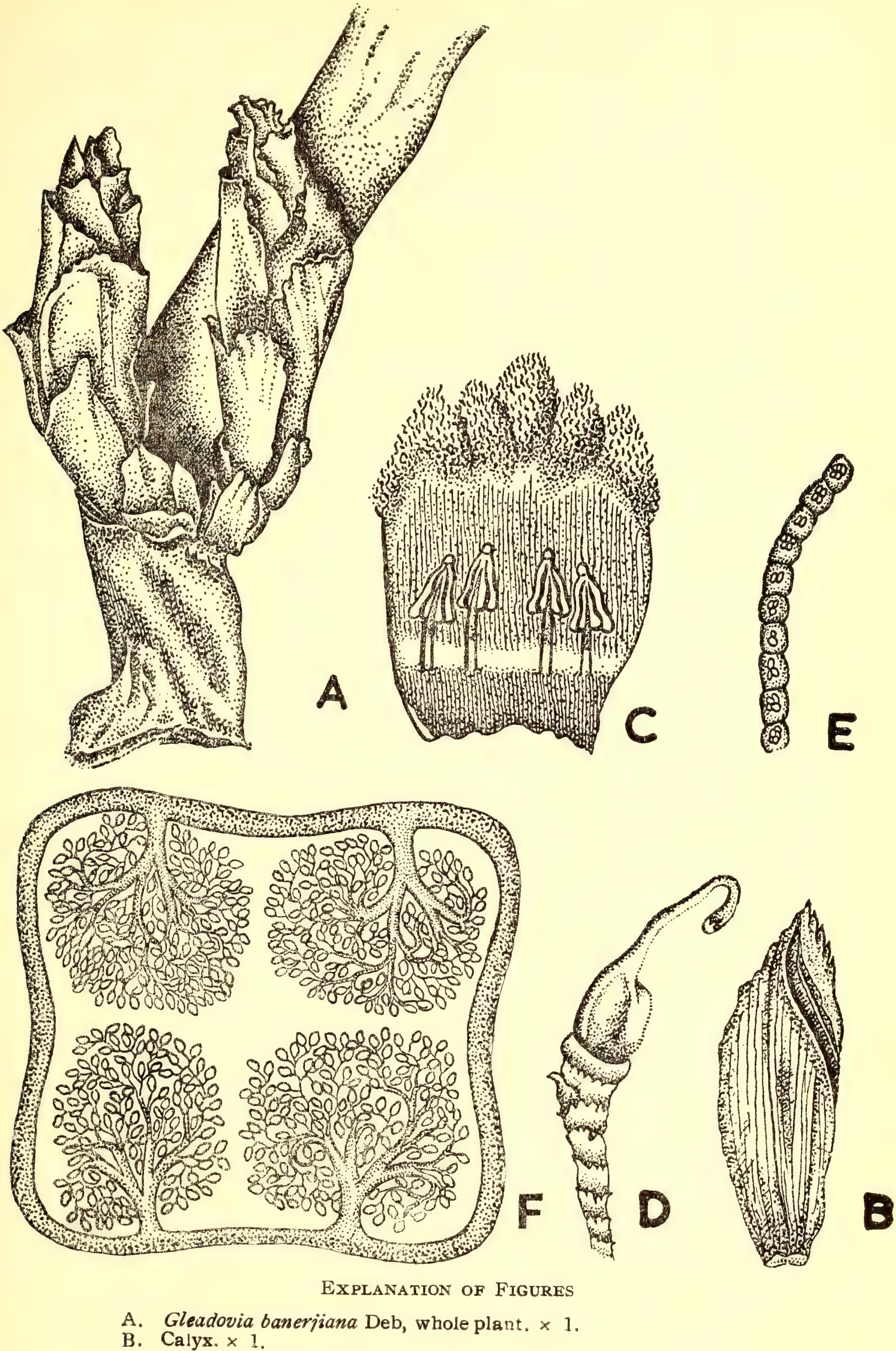
The type specimen has been presented to the Herbarium, Indian Botanic Garden, Calcutta. Cotypes have been presented to the Departments of Botany, Dhanamanjari College, Imphal, Manipur, and Maharaja Bir Bikram College, Agartala, Tripura.

Gleadovia banerjiana spec. nov.

Accedit ad *Gleadoviam kwangtungensem* Hu, a qua tamen differt bracteolis haud tomentosis, forma calycis, atque corolla hirsuta.

Planta parasitica minuta. *Culmis* ad 1 cm. altus, 3 mm. diam. *Inflorescentia* 1-3-flora, cymosa, floribus lateralibus haud evolutis. *Flores* ampli, subsessiles, 5-7.5 cm. longi, ca. 1.5 cm. diam., carnosi, hermaphroditi, hypogyni, gamopetali, breviter pedicellati, bracteolati, protandri; bracteolae numero 12, spiraliter dispositae, lanceolatae vel ovato-lanceolatae, spathulatae, adnatae ad basim, leves, latae, obtusae vel emarginatae ad apicem, magnitudinis variabilis, inferiores quidem minutae atque paucinervae, superiores vero multo majores atque plurinervae (0.4-3.2 × 0.3-2.5 cm.), nervis 3-32. *Calyx* gamosepalus, spathaceus, irregulariter 5-lobus ad apicem, fisus $\frac{1}{3}$ longit., 3.5-5 × 3.0-4.5 cm., nervis 52 parallelis. *Corolla* gamopetala, albida, rosacea vel pallide lutea, carnosa, 3.5-5.5 × 3-4.5 cm., nervis 33-35; corollae tubus latus, paulo incurvatus, dilatatus ad faucem, limbo obscure 2-labiato, lobis 5, erectis, patentibus, subaequalibus, obtusis, imbricatis, pilosis; pili moniliformes, 2-2.5 mm. longi, 10-15-cellulati. *Stamina* 4, epipetala, per 8 mm. corollae adhaerentia, inclusa, didynama; filamenta robusta, longiora quidem 4 mm. longa, caetera vero 2.5 mm. longa. *Antherae* attenuatae, adnatae, 2-lobae, utraque cellula perfecta, longitudinales, basi haud mucronata, tenuiter divaricata, connectivo producto. *Pollinis* grana sphaerica, levia, exino tenui. *Discus* annularis, fusce albidus, 1.5 mm. altus. *Gynoecium* syncarpum; *stigma* 2 mm. longum incurvum capitatum 2-lobum, tumidum; *stylus* robustus, 8 mm. longus glaber. *Ovarium* ovoideum, glabrum, superius, 8 × 8 mm. loculo unico, placentis 4 parietalibus dichotome bifurcantibus ubique ovuliferis.

Typus lectus ad Koupru collem, in regione Manipur ad partes orientales Indiae, altit. 6,000 ped. parasitus totalis ad radices *Strobilanthis discoloris* T. Anders. a D.B. Deb die 11 aprilis anni 1954, et positus in Herbario Hortus Indici Botanici ad Calcuttam sub numero *Deb* 2247; paratypi positi etiam in sectione botanica Collegii Dhana-



EXPLANATION OF FIGURES

A. *Gleadovia banerjiana* Deb, whole plant. × 1.
B. Calyx. × 1.
C. Corolla and stamens. × 1.
D. Pistil. × 1.
E. Trichome or hair of corolla. × 10.
F. Transverse section of ovary showing placentation. × 10.

manjari in loco Imphal, in regione Manipur, atque in Collegio Maharaja Bir Bikram, in loco Agartala, in regione Tripura.

This new species is named in honour of the author's revered teacher Dr. I. Banerji of Calcutta University.

The author expresses his thanks to Dr. D. Chatterjee, Superintendent, Indian Botanic Garden, Calcutta, for going through the manuscript, and to Rev. Dr. Fr. H. Santapau of St. Xavier's College, Bombay, for the Latin translation of the diagnosis of the new species.

DEPARTMENT OF BOTANY,
M.B.B. COLLEGE, D. B. DEB
AGARTALA, TRIPURA,
April 17, 1957.

22. *BOUGAINVILLEA BUTTIANA* HOLTTUM ET STANDLEY, AND ITS CULTIVARS IN LALBAGH, BANGALORE

(*With a text figure*)

Bor and Raizada[1] while compiling the species and cultivars of Bougainvillea cautioned that though chaos had not yet come upon us in the naming of Bougainvillea cultivars it could not long be delayed. But though not chaos, enough confusion has already crept in, in the naming of certain Bougainvillea cultivars. The greatest confusion I notice is in *Bougainvillea buttiana*.

The Bougainvillea 'Mrs. Butt' entered India under two names as B. 'Mrs. Butt' as well as B. 'Crimson Lake'. Percy Lancaster gave the name B. 'Scarlet Queen' to the same plant though according to him 'the coloured bracts are slightly darker than in B. "Mrs. Butt" but actual flower is malformed.'

Further the bud-sport from so-called B. 'Scarlet Queen' was named in Madras in 1932, as B. 'Mrs. Louis Wathen'. In 1931, B. 'Mrs. Butt' produced in Trinidad a bud-sport with apricot-orange bracts and it was named as B. 'Mrs. McLean'. The Madras plant B. 'Mrs. Louis Wathen' according to Nirody is from B. 'Mrs. Butt' and according to Percy Lancaster from B. 'Scarlet Queen'.

Now there are three names given to the same cultivar with crimson bracts, i.e. B. 'Mrs. Butt', B. 'Scarlet Queen', and B. 'Crimson Lake'. Likewise the bud-sport of the same plant with apricot-orange bracts bears two names, i.e. B. 'Mrs. McLean' and B. 'Mrs. Louis Wathen'. The malformation of flowers both in crimson bracts and apricot-orange bracts is the main difference.

For the last four years I have been watching with interest in Lalbagh the flower types on the cultivars bearing these names. On the same plant I have noticed all the different flower types, the flower types of B. 'Mrs. Butt' (on only one or two twigs) and B. 'Mrs. Louis Wathen' half the year (mostly in summer months) and the flower types of B. 'Scarlet Queen' (on the twigs which bear B. 'Mrs.

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[1] Bor, N. L. and Raizada, M. B. *JBNHS*, 47 (3): 403; 1948.

Butt' type of flowers) and B. 'Mrs. McLean' in other half of the year (mostly in winter months) on the same plant. These bushes originally planted as B. 'Mrs. Louis Wathen' are giving regularly flowers of these types according to the seasons. Likewise the bush planted as B. 'Mrs. Butt' bears half the year (mostly winter months) the flower types (malformation) of B. 'Scarlet Queen' and the rest of the year (mostly summer months) the flower types (perfect flowers) of B. 'Mrs. Butt'.

On Mrs. Louis Wathen

1.	Winter season—		
	(*a*) Mrs. McLean (Imperfect flowers and apricot-orange bracts.)	&	(*b*) Scarlet Queen (Imperfect flowers and crimson bracts on one or two twigs.)
2.	Summer season—		
	(*c*) Mrs. Louis Wathen (Perfect flowers and apricot-orange.)	&	(*d*) Mrs. Butt (Perfect flowers and crimson bracts on the twigs that bore B. Scarlet Queen.)

On Mrs. Butt

1. Winter season—	2. Summer season—
(*a*) Scarlet Queen (Imperfect flowers and crimson bracts.)	(*b*) Mrs. Butt (Perfect flowers and crimson bracts.)

All these flower types are found on Mrs. Louis Wathen at different seasons. I have noticed also the flower types of B. 'Scarlet Queen' (malformation) on B. 'Mrs. Butt' and B. 'Mrs. Butt' on Scarlet Queen. The only difference is the season. The Bougainvillea Mrs. Butt is one of the oldest Bougainvillea planted in Lalbagh. It came from Kew to Lalbagh in 1923. B. 'Scarlet Queen' came into Lalbagh in 1925. In 1926, both B. 'Mrs. Butt' and B. 'Scarlet Queen' were described as 'two new and very fine crimson red varieties'[1]. The malformation of flowers or perfect flowers appear only according to the seasonal variations. The malformation of flowers mostly in winter months is common to this species and its cultivars only. Lack of constant touch with these plants and, by chance, happening to see them at different seasons might have been the reason to describe the same plant under different names.

It is time therefore to remove the confusion. It is better that we recognise only the following, i.e. B. 'Mrs. Butt' (which is *Bougainvillea buttiana* proper) and B. 'Mrs. McLean', the bud-sport of B. 'Mrs. Butt'; and the rest treated as synonymous. B. 'Scarlet Queen' and B. 'Crimson Lake' may be treated as nothing but B. 'Mrs. Butt'; B. 'Mrs. Louis Wathen' as nothing but B. 'Mrs. McLean'.

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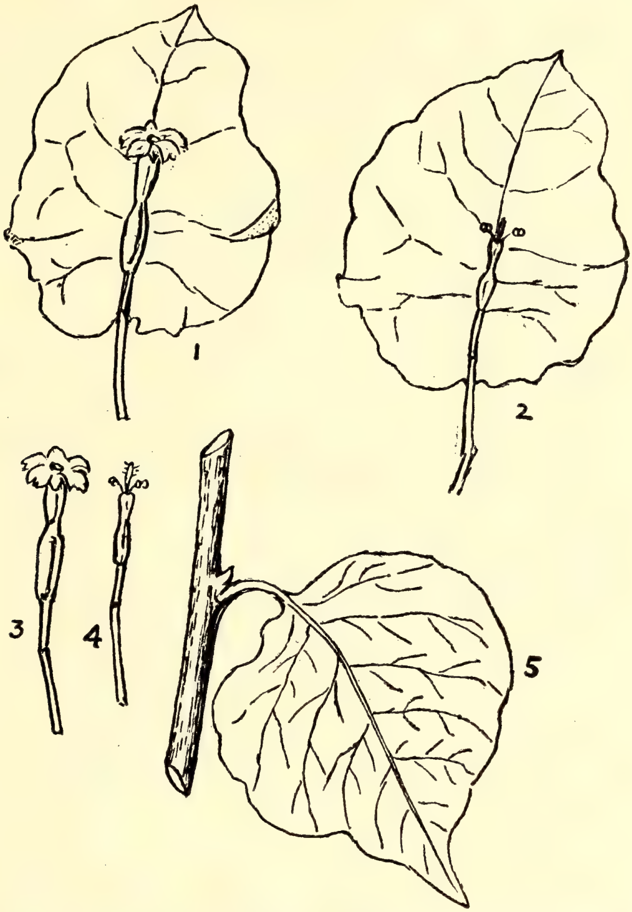
[1] Administration Report of the Government Gardens Department for the year 1926-27.

B. 'Mrs. Butt' (the species proper) in Lalbagh in addition to giving often bud-sport B. 'Mrs. McLean' has given also another bud-sport which has not been described or compiled by either Bor and Raizada or by Parsons, T. H.[1] This bud-sport which originated in Lalbagh is very popular and widely cultivated in gardens and also trained as standard Bougainvilleas in pots. The purple bracts are very distinct and showy. This has been named *Bougainvillea* 'Purple King'. This new cultivar also behaves like the parent plant in producing imperfect flowers in winter months. Another bud-sport of *Bougainvillea* 'Mrs. Butt' has developed variegated leaves, first noticed



Text-figure. *Bougainvillea buttiana* Holttum and Standley. (1) the bract with perfect flower (in summer months); (2) the bract with imperfect flower (in winter months); (3) Perfect flower (in summer months); (4) Imperfect or malformed flower (in winter months); (5) Leaf.

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[1] Parsons, T. H. The Tropical Agriculturist DCC 1935. *Bougainvillea* at Peradeniya, pages 337–347.

in the Central Food Technological Research Institute, Mysore, and named as B. 'Rao' after its selector. Mrs. McLean has given a bud-sport which bears yellow tinged bracts and it has been called B. 'Yellow Queen'. As its parent this also exhibits the malformation of flowers according to season. The species *B. buttiana* and its cultivars may be summarised as follows :

Species Proper:

1. *Bougainvillea buttiana* H. & S. (*B. 'Mrs. Butt'*).
   Syn: *Bougainvillea* 'Mrs. Butt', B. 'Scarlet Queen' and B. 'Crimson Lake'. Supposed to be of Brazilian origin with crimson bracts.

Bud-sport of B. buttiana (*B. 'Mrs. Butt'*).

1. *Bougainvillea* 'Mrs. McLean'. Syn. : B. Mrs. Louis Wathen. Originated as bud-sport on Bougainvillea Mrs. Butt in Trinidad and elsewhere with apricot-orange bracts.
2. B. 'Purple King'.
   Originated as bud-sport of B. 'Mrs. Butt' in Lalbagh. The purple bracts are quite distinct from the crimson bracts.
3. B. 'Yellow Queen'.
   Originated as bud-sport of B. Mrs. McLean—the yellowish tinge is dominating in the bracts as compared with the apricot-orange colour of the bracts in the parent plant.
4. B. 'Rao'.
   Originated as bud-sport from B. 'Mrs. Butt'. Its leaves are variegated. In all the other respects it is like B. Mrs. Butt. It was noticed, selected and grown by Sri S. Narasinga Rao (Asst. Superintendent, Parks and Gardens, Mysore) at the Central Food Technological Research Institute, Mysore. The plant is now in the Lalbagh collection of bougainvilleas.

It is worth noting that it is in this species and its bud-sports alone the malformation of flowers in seasons is observed and this malformation occurs regularly every year (see figs.). So far no other species of *Bougainvillea* have ever sown such malformation of perianth lobes in Lalbagh.

SUPERINTENDENT,
GOVERNMENT GARDENS IN MYSORE,
LALBAGH, BANGALORE-2,
April 4, 1957.

M. H. MARI GOWDA

23. SOME NAME CHANGES IN THE FLORA OF INDIA

Cochlearia cochlearioides (Roth) Santapau et J. K. Maheshwari. comb. nov.

Alyssum cochlearioides Roth, Nov. Pl. Sp. 322, 1821.
Cochlearia alyssoides DC. Prodr. 1: 172, 1824.
C. flava Buch.-Ham. ex Roxb. Hort. Beng. 48, 1814, nom. nud.; Hooker f. & Anders. in Hook. f. Fl. Brit. Ind. 1: 145, 1872.

This plant is listed in our floras under the name of *Cochlearia flava* Buch.-Ham.; this name, however, is clearly invalid, it being a nomen nudum in the sense of the Rules; when Roxburgh published it, he did neither give a description nor a reference to any previously published description. The oldest valid name is that of Roth, *Alyssum cochlearioides*, of 1821. According to the Rule of Priority, Roth's specific name must be replaced for the present species in accordance with the provisions of Art. 55 of the 1956 edition of the International Code of Botanical Nomenclature.

Tephrosia strigosa (Dalz.) Sant. & Mahesh. comb. nov.

Macronyx strigosus Dalz. in Hook. Journ. Bot. 2. 35, 1850.
Tephrosia tenuis Wall. Cat. 5970, 1831-32, nomen nudum; Dalz. & Gibs. Bombay Fl. 61, 1861.

The name *Tephrosia tenuis* like most of the names published in Wallich's Catalogue is a nomen nudum in the sense of the Rules, and therefore an invalid one. The oldest validly published name is *Macronyx strigosus* Dalz., and in accordance with the same Art. 55 mentioned above, the specific name *strigosus* must be reinstated for this plant.

Blumea obliqua Druce var. **pubiflora** (DC.) Mahesh., comb. nov.

B. pubiflora DC. Prodr. 5: 434, 1834.
B. amplectens var. *pubiflora* (DC.) C. B. Clarke in Hook. f. Fl. Brit. Ind. 3: 260, 1881.

The new combination for the variety is necessitated by the fact that the specific name has been changed to *Blumea obliqua* by Druce in Bot. Exch. Club. Brit. Isl. Rep. 4: 609, 1917, based on *Erigeron obliquum* Linn. Mant. 2: 573, 1771. This variety is common on sandy soil in the neighbourhood of Okhla near Delhi.

In addition to the present variety, C. B. Clarke mentions three other varieties in the Fl. Brit. Ind. The following new combinations are proposed for these varieties:

Blumea obliqua var. **arenaria** (DC.) Mahesh. comb. nov.

B. arenaria DC. Prodr. 5: 433, 1834.
B. amplectens var. *arenaria* Clarke, loc.. cit.

Blumea obliqua var. **maritima** (Clarke) Mahesh. comb. nov.

B. amplectens var. *maritima* Clarke, loc. cit.

Blumea obliqua var. **tenella** (Clarke) Mahesh. comb. nov.

B. amplectens var. *tenella* Clarke, loc. cit.

BOTANY DEPT.,
UNIVERSITY OF DELHI,
DELHI 8,
April 17, 1957.

J. K. MAHESHWARI

GLEANINGS

EXTRACTS FROM I.U.C.N. BULLETIN VOL. VI, NO. I (MARCH 1957)
SELECTED AND ANNOTATED BY R. W. BURTON

Nature is Protected

In the Editorial, Mr. Jean-Paul Harroy observes that under the impetus of those who made an aesthetic approach to the subject and were anxious to campaign against the disfigurement of beautiful places, biologists added their backing to the cause by emphasizing the danger of destroying natural habitats, such as hedges, spinneys, ditches, etc., without considering the consequences for the small mammals, birds, and insects that live and breed there normally, and whose loss would impoverish the biotope.

Problems of Population

'Medical science has led to death control but not birth control.'

'It seems pertinent to quote some striking examples that have been used in articles and in Press interviews given by the eminent biologist, Dr. Julian Huxley.

'The human race is increasing by about 90,000 people, the equivalent of a good-sized town, every day of the year.

'When projected health measures come into force in India, and if the death rate is cut to the extent that the Ministry of Health expects, and if the birth rate remains at the present level, within a few years India's annual increase of population will be some eight million—equivalent to adding a new London every year !'

Our Life Blood—The Soil

In the Yugoslavian magazine, *Zastite Provada* (December 1956) effective measures of fighting erosion are described as based on a study of the factors by which the water run-off from slopes can give rise to erosion. In the United States the principle is adopted that installation of drains follows the contours—even up to 200 miles—and seems to give satisfactory results. Certain problems still remain, but it has already been made possible to provide a better percolation of water in areas of heavy rainfall. This certainly benefits the vegetation, helps to purify the rivers and increases the possibilities of the yield from the soil.

Precarious Balance

Referring to Bulletin, Vol. I, No. 1, January 1952, it is stated that thousands of rats are delaying the construction of Africa's largest aerodrome by gnawing at the foundations of the 1,500-yard-long runway. Large teams specialised in control of rats have had to be called in to tackle the problem.

The rats apparently have been breeding to excess ever since snakes had to be exterminated to ensure the workers' safety.

Here is yet another of the many instances of adverse results consequent on man's interference with Nature. There is no doubt in Africa a species of non-poisonous snake similar to the common Rat Snake of India (*Ptyas mucosus*) which could be released at the site to deal with this plague of rats.

This would be a sure, natural and inexpensive way of solving the trouble.

A novel method of Fishing.

'And so, in the half-light of the day's beginning we silently crossed the Lena . . .

Inconsequentially someone started to talk about fish. . . . I told the others that in winter in Poland it was possible to catch fish by hammering a hole through the ice. . . . I explained, the fish stunned by the hammering will be forced out through the change of air pressure when the ice is broken through. . . . Kolemenos went off and returned with a solid baulk of timber . . . We started thumping away with pile-driver blows. Eventually we broke through. The water gushed up like a geyser, swirling icily round our feet. And yes ! There were fish—four of them, about the size of herrings.'

(THE LONG WALK by Slavomir Rawicz, page 100).

An experimenting Siberian bear.

'Zaro burst back into the tent. "Somebody's playing the violin out there", he shouted. . . . The description of someone trying to play a violin was setting it a little high musically. It was like the plucking of a string on a double-bass. The note was loud and sustained, dying gradually away. . . . We looked at one another in wonderment and started a stealthy general move in the direction of the sound. . . . We were on the edge of a clearing, on the other side of which was a tree blasted by lightning. The main trunk had fallen outwards from the clearing without having torn itself completely free of its lower part. At the break, about five or six feet above the ground, a long splinter stuck straight up. And as we watched, the splinter was drawn back until it was bent like a bow. Then it was released and the "music" vibrated on our ears. And the performer? A great, black Siberian bear, reared up on his hind legs to his full and impressive height.

Peering round trees we saw him pull at the splinter again and again, standing each time with head on the side listening in comical puzzlement to the sound he was producing. The performance lasted several minutes before he got tired of it and shambled off—away from us.'

(THE LONG WALK by Slavomir Rawicz, page 107.)

Search for Golden-fleeced Merinos in Australia.

The golden fleece of Greek legend has become a reality in Australia. At least four golden sheep have been found in New South Wales, reports Radio Australia News.

The first was discovered a month ago in a normal flock. Although its fleece was shining yellow, the animal was obviously of the merino type.

The Commonwealth Scientific and Industrial Research Organisation promptly asked graziers to search their flocks for golden fleeces, and began to investigate the possibility of using the wool commercially. The scientists believe the sheep are mutations or pure genetic accidents. So far they have collected four golden sheep, and samples of the golden wool from nine different districts of New South Wales.

[From *International Wool Secretariat News Service*, No. 54, dated New Delhi, 20th April 1957.]

Alarm Calls of Peacock.

'The peacock is a most valuable guide to the hunter, from the peculiar note of alarm it invariably utters if there is a tiger or panther moving in the cover. Perhaps the noise of the beaters first commencing, a single warning sort of call "h-a-u-k!" (like a note from a trumpet) is heard at intervals from one or more peacocks answering each other from different parts of the cover. At this sound the heart beats high, for he has good cause to shortly expect a sight of his game. If it is followed by the rapid rising of peacocks in succession, each uttering its loud cry of "tok-tok, tok-tok!" as it flies off, evidently in the greatest fright, his hopes amount to a certainty; but sometimes only to be dashed by the appearance at last of some miserable sneaking wild cat, whose approach has been heralded by quite as much calling from the peacocks as if a tiger itself was present. Rarely, and then seemingly only by mistake (for the call is not repeated by the other birds), does a peacock sound the alarm, if merely a bear or any number of hog and deer should be rushing through the bushes crashing down all before them. This is accounted for by the fact that they are chiefly preyed upon by the cat tribe . . . .'

[From TIGER-SHOOTING IN INDIA, by Lt. William Rice, 1857.]

Political Officer and Panther.

'Certain individuals, otherwise undistinguished, achieved wide and lasting fame by virtue of some spectacular episode of the jungle. One officer attacked by a wounded panther, had saved his life by seizing the animal by one of its hind legs and swinging it round and round until it was too dazed for further aggression.'

[From TWILIGHT OF THE MAHARAJAS, by Sir Kenneth Fitze, K.C.I.E., 1956, p. 17.]

NOTES AND NEWS

Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, has been elected President of the Zoological Society of India for the period 1957-1959. He has also been appointed a member of the International Advisory Committee on Humid Tropics Research (UNESCO, Paris) and is now Honorary Secretary-General of the Indian Board for Wild Life.

DARWIN CENTENNIAL EXPEDITION

'The Darwin Anniversary Committee, Inc., has announced that Charles Darwin's historic round-the-world trip, which helped him formulate his theory of evolution, will be retraced in 1958. The year 1958 was chosen because it will be the centennial of Darwin's presentation of his paper to the Linnaean Society in London outlining his theory of evolution. Julian S. Huxley, the biologist, is Honorary Co-Chairman of the Planning Committee. Lady Nora Barlow, a descendant of Darwin, is the other co-Chairman.

'Darwin sailed in the British ship *Beagle* as official naturalist on a surveying trip. The expedition, which took place between 1831 and 1836 visited islands in the Atlantic, the coast of South America and adjacent islands, and islands of the western Pacific. The Darwin Committee plans to cover the same areas in a year's time, using a 100- to 150-foot sailing ship with auxiliary engines.

'On his trip Darwin studied native people and the flora and fauna of the areas. The modern voyage will compare ecologic conditions today with those of 125 years ago. The 1958 trip also will seek to determine if any species of flora and fauna are in danger of becoming extinct. In the next few months about 20 scientists, both men and women, will be selected as Darwin fellows to sail on the expedition. Others probably will be flown to the research areas.'

[*Current Science*, Vol. 26, No. 3: 71, March 1957.]

THE INTERNATIONAL COMMITTEE ON LABORATORY ANIMALS

It is good news to hear that something is now being done to care for the animals that are used as raw material for biological and medical sciences. An International Committee has been set up under the auspices of the International Union of Biological Sciences and the Council for International Oraganisation of Medical Science, with the assistance of the UNESCO, to help solve problems arising from the increasing use of laboratory animals.

Some of the problems that the Committee will have to face are: (1) definition of common terms used in relation to laboratory animals with regard to genetics, disease and parasitism, nutrition, care and performance; (2) the compilation of a world list of strains of laboratory animals; (3) the selection of suitable centres for the production of animals achieving a high and refined quality, or for the maintenance of master stocks of such animals; (4) problems which relate to the supply of suitable animals; (5) the investigation of customs, quarantine, and other regulations governing the international shipment of laboratory animals; (6) the need for establishing an information centre on laboratory animals; (7) for laying down standards of education and training for animal technicians; (8) for creating internationally recognised standards for laboratory animals and for testing animals claimed to attain such standards; and (9) for furthering the dissemination of knowledge on this subject possibly through symposia or congresses.

With the information thus gathered 'the experimental biologist can look forward to being able to state precisely what animals he has used or wishes to use, in terms that are universally accepted, so that his colleague in another continent will know immediately the nutritional requirements, the state of freedom from specific infection, the pedigree and the possible sources of the same strain'.

[*Nature*, Vol. 179 (4553): 240-241, February 2, 1957.]

* * * *

The Rajasthan Government have established the Keoladeo Ghana of Bharatpur as a sanctuary for breeding water birds. They have published an attractive illustrated brochure describing the place and its birds in order to publicize the sanctuary. This booklet can be had from the Bombay Natural History Society at Rs. 2-8-0 per copy, and all further information required by intending visitors from the Divisional Forest Officer, Bharatpur.

* * * *

We regret to announce the death of Sir Norman Kinnear who retired in 1950 as Director of the British Museum, and who was the Curator of the Bombay Natural History Society from 1907 to 1919. An obituary notice will appear in the December number of the Journal.

* * * *

Illustrations of the following animals suitable for publication in the projected second edition of Mr. S. H. Prater's THE BOOK OF INDIAN ANIMALS are required:

Slender Loris, Tiger, Fox, Wolf, Smaller Onehorned Rhinoceros, Gaur, Wild Buffalo, Nilgiri Tahr, Blackbuck, Swamp Deer, Common Mongoose, Lion, Goral.

The Society would be grateful to members and others who may be able to assist. Copies of pictures or photographs available may kindly be sent to the Society's office at an early date.

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Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS should preferably be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names, to be printed in italics, should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and sub-specific names always begin with a small letter even if they refer to a person or a place, e.g., *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri.*

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 3¼ × 2¼ inches (No. 2 Brownie) and on glossy glazed paper.

6. Text figures, line drawings and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books ***not*** underlined (roman type), thus:

Roepke, W. (1949): The Genus Nyctemera Hübner. *Trans. ent. Soc. Lond.*, **100** (2): 47-70.

Prater, S. H. (1948): The Book of Indian Animals, Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Roepke, 1949).

9. *Synopsis*: As recommended by the Royal Society Scientific Information Conference (July 1948), the editors consider it desirable that each scientific paper be accompanied by a synopsis appearing at the beginning, immediately after the title. The synopsis should be factual. It should convey briefly the content of the paper; draw attention to all new information and to the author's main conclusions. It should also indicate newly observed facts, the method and conclusions of an experiment, and if possible the essential points of any new finding, theory or technique. It should be concise and normally not exceed 200 words.

When the synopsis is completed it should be carefully revised by the author to clarify obscurities, and further compressed wherever possible without detracting from its usefulness.

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BOMBAY NATURAL HISTORY SOCIETY

Vol. 54, No. 4

Editors
SÁLIM ALI & H. SANTAPAU, S.J.

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Reprints of a few papers of the Indian Helminthologist, the (late) Dr. G. D. Bhalerao, *Indian Journal of Helminthology* and Prof. Thapar Sixtieth Birthday Commemoration Volume, 1953, could also now be had from the Office of the Honorary Treasurer, Dr. B. S. Chauhan, 34, Chittaranjan Avenue, Calcutta-12, India.

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THE BLACKFACED WEAVER BIRD OR DIOCH IN WEST AFRICA:

AN ECOLOGICAL STUDY

BY

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(*With four plates, one text figure, and three graphs*)

During the last few years there has been growing concern at the damage done by the various subspecies of *Quelea quelea* to the grain crops in African territories. In some parts of the big thorn-scrub and savannah belt which extends from Sénégal to the Sudan and thence to Kenya, Tanganyika, the Rhodesias, and South Africa this bird has become a large-scale pest. Losses of wheat amounting to over two-thirds of the total crop have been reported in parts of East Africa, and similar damage has been caused to rice in Sénégal and sorghum in South Africa. No wonder this dioch is now compared by modern agriculturists to locusts in the losses which it causes!

The problem has even become so urgent that the governments of French West Africa, the Union of South Africa, and Tanganyika have appointed full-time zoologists to study the biology of the species in all its aspects, while other officers have been concerned with research into methods of control. To strengthen international co-operation in that field the Scientific Council of the Committee for Technical Co-operation South of the Sahara (C.S.A.) organised a first specialist conference on *Quelea* which was held in Dakar and Richard-Toll from 31 October to 5 November 1955. The proceedings of this important meeting have not yet been published in full, but a summary of the discussions has appeared in *The Ibis*, volume 98, 1956, pp. 538-541. A second specialist meeting on the same subject will be held this year in Livingstone, from 29 to 31 July, after the first Pan-African Ornithological Congress.

The French research programme on the ecology of the Blackfaced Dioch has been made possible through the generosity of the *Mission*

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d'Aménagement du Sénégal (Sénégal Planning Council), a state organism mainly concerned with the agricultural development of the lower Sénégal Valley. A research station has been organised by the two junior authors (G.M. and M-Y.M.) at Richard-Toll, in the heart of the big irrigation zone which is progressively turning that formerly barren part of the country into rice-fields. Laboratory work and breeding experiments have been conducted there since 1953, when most field observations were made in the area shown in the accompanying map (figure 1). The senior author (F.B.) has been responsible for the planning of the research programme and was fortunate enough to take part in two field trips, in April 1954 and August 1955.

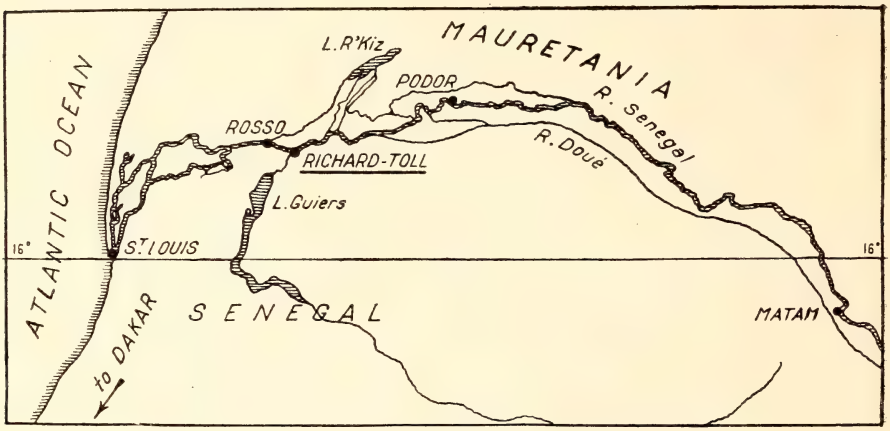

Figure 1. — Our study area, the lower Sénégal Valley.

THE BIRD

Three different subspecies of the Blackfaced Dioch are usually recognized. *Quelea quelea quelea* ranges from Sénégal to Bornu across the thorn-bush and grass savannah north of the Congo forest. *Quelea quelea aethiopica* lives in the Sudan and East Africa, intergrading in South Tanganyika and Northern Rhodesia with the South African subspecies *Quelea quelea lathami*.

The plumage of the typical race, to which our birds belong, show interesting variations. Normal males during the breeding season are usually easily recognized by their black face, their strong bright red bill, and the yellow edges to their primaries. The legs are salmon coloured and the eyes lined by a red eye-ring. But some specimens are quite different. The black forehead may be greatly reduced and even disappear completely. Moreover, the crown, the nape, the breast, and even the whole underside may be more or less suffused with pink. Such birds have been formerly given a special name (*Quelea russi*) but they merely constitute a phase—whose genetic mechanism still remains to be worked out—which can be met with in various proportions in the different populations. In our area it forms from 20 to 25 per cent of the male breeding population. The behaviour of such birds does not appear to differ from that of the normal ones. The prenuptial moult starts at the very end of April and is completed in the middle of July.

In the middle of November, the males resume very quickly a sparrowy plumage; their beak becomes somewhat paler and they are no longer distinguishable in the field from the females. Such postnuptial moult appears to be rather strictly timed and sometimes abruptly interrupts a late breeding season.

Females keep a sparrow-like plumage all the year round, but show marked seasonal variations in the colour of the bill. During the breeding season it becomes lemon-yellow, turning red again as soon as the reproductive period is over.

Immature birds have the same sparrowy plumage as the females and the non-breeding males. When they leave the nest the bill is flesh-coloured and it does not turn red before the next breeding season. The postjuvenal moult does not begin before the end of January.

THE ENVIRONMENT

The Blackfaced Dioch is a typical bird of the semi-arid (Sahelo-Sudanese) zone of West Africa.

In that part of the continent, the year is rather sharply divided into two periods of unequal duration: a long dry season from November to June, and a short rainy season from July to October. At Richard-Toll the average annual rainfall is of 350 mm., but important variations may occur from year to year, as shown in the following table:

TABLE 1

Monthly variations of the rainfall at Richard-Toll, from 1953 to 1956 (in mm.).

	1953	1954	1955	1956
May ...	0	0·6	2·8	0
June ...	29·5	18	52·5	0
July ...	58	25	90	29
August ...	121	182·5	143·8	42·2
September ...	130·2	22·5	87·8	212
October ...	56·2	5·7	15·4	36·7
Total ...	394·9	254·3	392·3	319·9

The rains bring on a spectacular change in the plant and animal life of this part of Africa. In a few weeks the parched thorn-bush turns into a pleasant park-like savannah. Insects become very numerous, flowers may be seen everywhere and many birds assume their breeding plumage.

The flora of our study area is not very rich, as compared with the southern parts of Sénégal and Gambia. The more numerous trees are two species of Mimosoideae, *Acacia senegal* and *Acacia tortilis*, and one Simaroubaceae, *Balanites aegyptiaca*. These are the species regularly chosen by the Blackfaced Dioch to build its nests, and it seems worth noticing that all these trees are very thorny. Such is also the case with a bush of the genus *Zizyphus* which can also be used as support for the nests. On the contrary three other species of trees living in the same plant community, but without thorns, *Bauhinia reticulata*, *Bauhinia rufescens* (Caesalpinioideae) and *Leptadenia spartium* (Asclepiadaceae) are never used by *Quelea*. On seasonally flooded areas, along the Sénégal River, dense stands of *Acacia scorpioides* are found. They are seldom used by *Quelea*.

The grassy stratum is made up principally of a number of species of Gramineae whose seeds constitute the staple food of the adult Blackfaced Diochs all the year around. Millet (*Sorghum* and *Pennisetum*) grown near the human settlements, and rice now introduced in the irrigation zone around Richard-Toll, are to be added, of course, to the list of the seeds regularly eaten by these birds. The amount of grain actually consumed by the diochs is nevertheless but a small part of their depredations, far more rice being crushed and spoilt by the weight of the birds alighting on the crop than eaten by them !

LIFE HISTORY

The Blackfaced Dioch is an extremely gregarious bird, living in flocks all the year round. During the rainy season adults usually gather in large colonies harbouring millions of birds. Once the breeding is over these huge swarms break up into much smaller flocks which scatter over the whole semi-arid belt. Such flocks nevertheless usually congregate for the night in densely packed roosts, very often located in the same places from year to year. Both nesting colonies and nocturnal roosts of the non-breeding season thus offer excellent targets for control of the birds, and have so far proved most vulnerable.

Our description of the life-history of *Quelea quelea*, as summarized in the present paper, is based on studies made both in the field and in captivity. From 1953 to 1956 we were able to study closely numerous nesting colonies located in various parts of the lower Sénégal Valley. Such field-work enabled us to describe the various stages of nest construction, and to make extensive observations on clutch-size, growth, food-consumption, and mortality of the nestlings. Moreover, we were lucky enough, in 1955 and 1956, to breed for the first time Blackfaced Diochs in captivity, in our aviaries at Richard-Toll. Thus we were able to analyse more closely the various behaviour patterns of this gregarious weaver and to make preliminary experiments on the influence of some ecological factors which probably play a role in the timing of their reproductive cycle.

Nesting Sites. In our area nesting always takes place in thorny trees, mainly *Acacia senegal*, *Acacia tortilis* and *Balanites aegyptiaca*, and is always colonial. A certain density of trees is therefore necessary for the establishment of the big colonies and we have so far found an average of 50 trees per hectare[1] to be the rule in most cases. But in some nesting sites the density of trees can be much higher, up to 300 per hectare.

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[1] 1 hectare = 2·471 acres

The number of nests per tree is even more variable, from a few scores to more than a thousand. On the average a five metre high acacia tree harbours about 200 nests, but the *Balanites*, probably on account of their countless long spines, may be covered by thousands of nests and look like hay-stacks.

The size of the nesting colonies is likewise variable. Fifty hectares can be taken as an average, but colonies as large as 400 hectares have been found. The total population of such aggregations is therefore tremendous. If we take, for instance, an average colony of 50 hectares where the number of trees is 50 per hectare and the number of nests 200 per tree, we reach a rough total of 500,000 nests ! This is an average figure and the largest colonies can certainly contain up to 10 million nests.

Some very small nesting colonies are nevertheless met with from time to time. In 1953 we found near Dara (100 km. north-east of Rosso) in Mauretania very small colonies established in scanty gum trees between sand dunes. Again in 1954 we found colonies of less than 10 trees, and H. J. de S. Disney and J. W. Haylock (1956) tell us of similar small nesting sites in the Rift Valley. On the other hand, our breeding experiments of 1955-1956 conclusively establish that a colony of as few as five pairs of Blackfaced Dioch can reproduce successfully.

Besides a sufficient density of trees, the establishment of a nesting colony of *Quelea quelea* seems to require at least two other environmental conditions : the vicinity of water and sufficient herbaceous cover. As a matter of fact the nesting colonies are never located very far from rivers, lakes or at least temporary water holes, and that explains probably why the nesting sites are so numerous around R'Kiz Lake and along the banks of the Sénégal River. Moreover, the quantity of grass necessary to build so many nests and the amount of seeds needed to support millions of birds during the whole breeding season make the presence of a dense cover of Gramineae an absolute necessity.

The combination of these various requirements—a sufficient density of trees, the proximity of water and the presence of a dense grass cover—probably explains why Blackfaced Diochs show some tendency to use again their old nesting sites, despite their regular destruction. This is quite obvious around R'Kiz Lake in 1954, 1955, and 1956, and similar instances have been reported in Tanganyika.

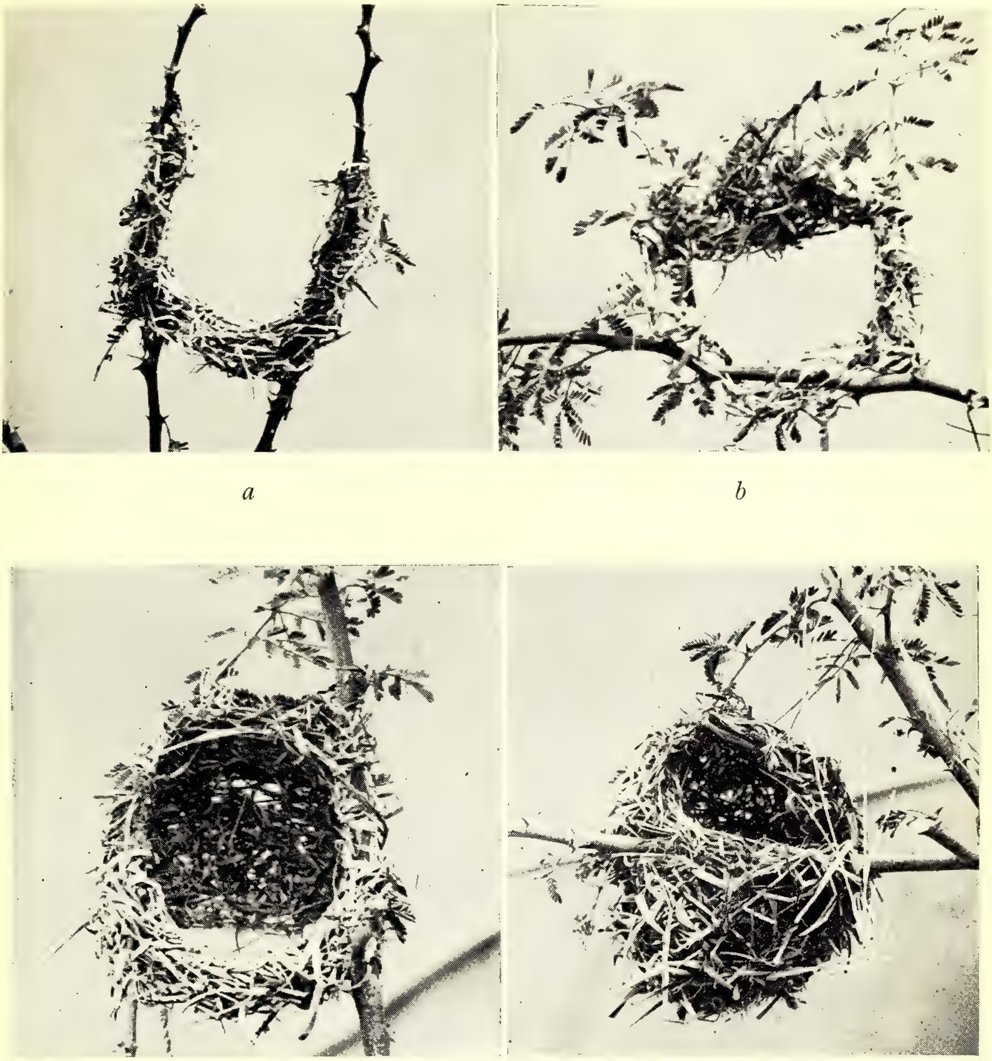
In some places *Quelea quelea* breed in rushes over water, despite the presence of apparently suitable trees in the neighbourhood. Such is the case in some parts of the French Sudan (Dekeyser, 1955) and also in East Africa. As yet, we have not found any evidence of the presence of this 'juncicole type' in our study area.

Nest-building and Pair-formation. *Quelea*'s nests are rather loose but strong round structures, firmly attached to the surrounding twigs and thorns. They do not hang nor do they have a funnel-like entrance like so many weavers' nests, and are made entirely of grass.

They are built by the males which start by twisting and knotting, mainly with the bill, long green stems of Gramineae around surrounding twigs or thorns; such a 'bridge' is then rapidly enlarged into a crescent-like structure which gradually becomes an upright ring. Work proceeds by the construction of the roof and the sides of the nest (double opening stage) before completing the cup (pocket stage).

These first stages of the nest building do not take a long time—about four days according to our field observations at El Khatt colony in August 1955. At that time the males are often seen displaying in a very peculiar manner. They raise and flutter their wings, elevate their tail, fluff slightly their contour and head feathers and sing a short sentence. Such a posture has been called 'butterfly display' by J. H. Crook (in preparation) and 'territorial display' by Morel and Morel (1957). The function of such a display is obviously to attract the females which are starting to visit the constructing males at that time. During our 1956 breeding experiments one of our males regularly indulged in butterfly display when a female was nearby. But this posture may likewise be assumed to threaten a male intruder, as shown by our observations at the Palm Grove colony on August 24, 1955, and in our aviaries on October 21, 1956, when two marked males were trying to build together the same nest. The aggressiveness of the males during these first stages of the nest building is very strong indeed, and their territorial behaviour well developed. Actual fights are frequent and death of one of the antagonists may ensue. Under a single small tree, on August 25, 1955, at the Hassi Leben colony, we found the dead bodies of two males, one with the right eye torn out. That is why we misinterpreted at first this posture and called it 'intimidation display' (Morel and Bourlière, 1956). The butterfly (territorial) display is seen during the first four stages of the nest-building, until the pocket stage. When a male has abandoned a first nest and started building a new one, it resumes that posture.

At about the fifth day of nest-building, when the whole structure is almost completed but the entrance still too large and lacking the 'pent house', the male stops building and pair-formation takes place. As early as the 'pocket stage' males get more and more interested in the visiting females and butterfly ('territorial') display gives way to the 'connubial display'. Both sexes quiver more or less quickly their half spread and dropped wings, fanning their tail and fluffing their contour feathers. Initiative is usually taken by the male, but sometimes by the female. In 1955 we thought that the yellow bill of the mature female could act as the specific releaser of pair formation in *Quelea*, and we accordingly undertook a few field experiments with dummies (stuffed females with bills painted yellow or red). Our observations failed to disclose any obvious difference between the response to the yellow-billed and the red-billed dummies; both were attacked by the male 'owners' when placed on their nests. On the other hand, a small proportion of females retain a pink bill at the time of pair formation; on August 24, 1955, at the Hassi Leben colony, we found that 60 out of 270 females (i.e. 22%) still had a more or less reddish bill. Both kinds nevertheless behaved in quite the same way.

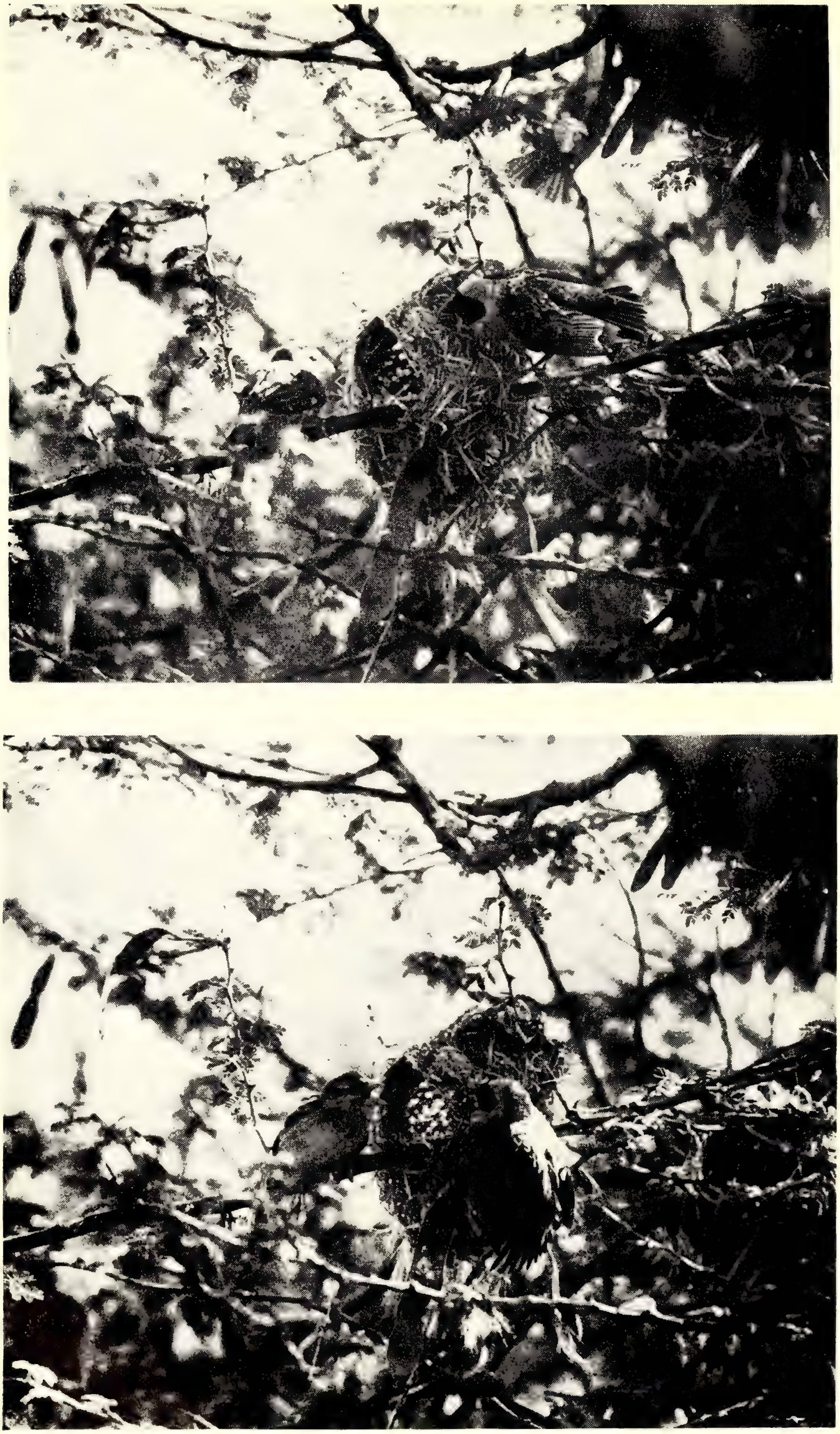


a *b*

c *d*

The various stages of nest construction in *Quelea q. quelea*. *a*. The "crescent" stage, *b*. the "ring", *c*. the "double opening" stage, *d*. the "pocket" stage.

Photos : F. Bourlière



The connubial display near the still unfinished nest.

Photos: G. Morel

The duration of the pair-formation stage is quite short. At El Khatt, in August 1955, the first copulation was noted on the 24th at 10.40 a.m., but the same day at 6.15 p.m. we watched a 'frenzy of copulations' everywhere in the colony. The next day no more copulations were noticed and the first eggs were laid. As soon as the pair is formed it remains stable and the males pay no attention to the unattached females displaying near their nests. Both sexes take part in the defence of the nest, but we never observed the female adding material to it. The nest itself is quickly completed by the male, but no lining is added and the structure remains quite permeable. Neither eggs nor nestlings seem to suffer from such a situation, even after a prolonged night storm (Hassi Leben, 1954).

On the whole, the building of these colonies harbouring millions of birds does not take more than a week. Tons of green grass must therefore be readily available to afford the necessary material.

The bigger colonies of Blackfaced Diochs appear to exert a strong attraction on the smaller ones which happen to be present in the neighbourhood and which may be deserted at a more or less early stage. At the beginning of the breeding season of 1955, swarms of *Quelea* were watched from an observation plane by M. Bessac leaving their nesting places south of R'Kiz Lake and heading towards the Hassi Leben colony where they settled to breed. Such unsustained attempts at nesting have also been observed in 1954 and 1956; this behaviour deserves closer study.

In all breeding colonies so far studied the sex-ratio of the adult birds was found to approximate 50 : 50. No evidence of polygyny has ever been found.

Egg-laying, Incubation, and Development of the Young. The first eggs are laid 24 hours after pairing and before the nest is completed. As a matter of fact laying often takes place when the structure is still so thin that the eggs can be seen from outside. In some cases the urgency to lay causes females to drop their eggs on the ground. On August 25, in the morning, under a small tree of the El Khatt colony, we found no less than 20 such eggs!

Clutch size, as discussed later in this paper, ranges from 1 to 6 eggs, clutches of three being the more numerous. Larger clutches (35 eggs in one case) are certainly due to the laying of several females in the same nest (Lemoileh colony, 1954). Such abnormal clutches were spontaneously abandoned by the birds. *Quelea* eggs are 18.3 × 14.2 mm. in size and are a pale greenish blue in colour with no markings.

Brooding is carried out by both the male and the female by day, but at night only the female broods (Boul colony, 1953). In the daytime, incubating parents never stay for a long time on their eggs. On September 4, 1955, for instance, a female was seen to leave and enter her nest 21 times during 41 minutes of continuous observation. Such brief periods of actual sitting has been noted in every colony we have studied as well as in our aviaries. Such a peculiar brooding behaviour is probably made possible both by the very high environmental temperatures (which can reach 40° C. in the shade at noon) and by the loose structure of the nest (which prevents overheating). That *Quelea* eggs do not need close attendance to be able to hatch is proved by an experiment we made in 1956 at the Hassi Leben colony. On October 6, eggs were collected at random from various nests and kept for two days under our tent before being subsequently replaced in occupied nests. On October 15, these 26 eggs which had not been brooded for almost 50 hours had given birth to nine apparently normal young.

During incubation the connubial display gives way to a slightly modified posture which we called 'greeting display' (Morel and Morel, 1947). Whenever a bird arrives on the nest, both male and female start quivering their half-spread wings which are held at an horizontal level (and not dropped as in the connubial display). Moreover, the contour feathers are held sleek and not at all fluffed out. Such behaviour has quite probably a social significance, helping to maintain the pair-bond.

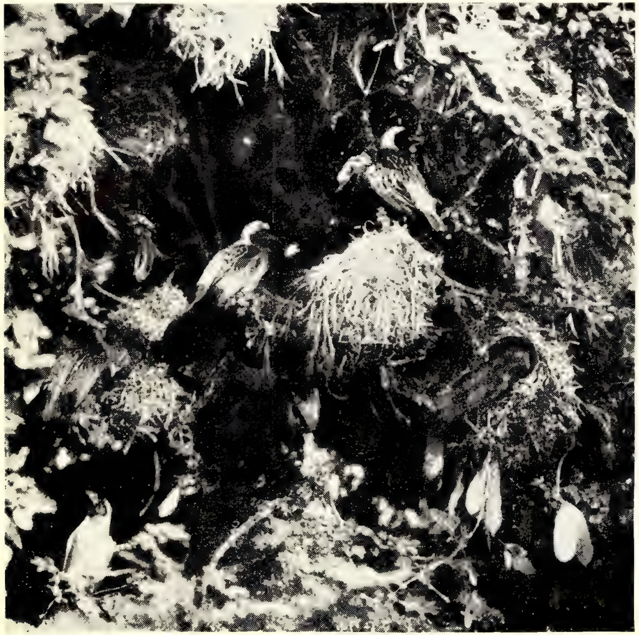
Territorial behaviour and aggressiveness continue to be noted during the incubation period. As before, the territory continues to be restricted to the nest itself and its immediate surroundings, like the favourite perches close to its entrance. Both sexes take part in its defence as shown by our 1955 experiments with stuffed birds placed on the nests at various stages of the incubation period. Threat displays used in territorial defence can consist simply of facing the intruder and pointing the bill in its direction, until it flies away. Meanwhile the 'owner' fluffs its head and contour feathers, often raises and spreads its tail, utters a harsh sound, and often makes a few intention flight movements. When the intruder gives up, it lowers its head while the winner keeps its own raised. When such a threat does not suffice, the 'owner' may chase the intruder and actual fights take place. Robbing straws from the nest frequently releases such aggressive behaviour.

Both in the nesting colonies we studied in Mauritania in 1955-1956 and in our aviaries in 1956, the incubation period lasted 12 days.

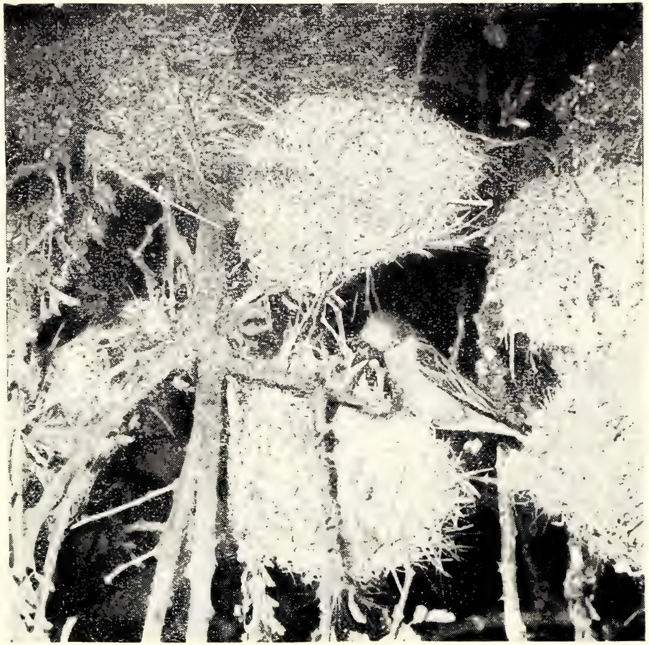
The nestlings are fed by regurgitation from the parents' crop on a mixture of little grass seeds and insects, mainly grasshoppers and caterpillars. Hemiptera and Diptera can also be taken. The amount of insects eaten by the young Blackfaced Diochs for some days after hatching ranged from 35 to 50 per cent of the total volume of food found in the 433 crops collected in 1953 and 1954.

Both parents share the feeding of the young, as shown by the continuous observation of a nest at Boul's colony on October 16, 1953.

Adults do not forage alone to collect the food needed to raise their brood. As soon as they have delivered their crop content to their young, parents usually fly to the top of the nesting tree and wait till a foraging flock flies by. They join it immediately and thus go away from the colony. It is likely that such birds usually collect their food at short distances from their nesting place; but that is not always the case. At the Tambass colony, for instance, we found in 1954 rice seeds from the ricefields of Richard-Toll (25 km. away, as the crow flies) in the crops of some young.



Males "standing guard" on their nests. Incubation stage.



Male feeding the young.

Photos: G. Morel

The traps used for catching immature Queleas.

The aviaries for breeding experiments, Richard-Toll Ornithological Station.

Photos: G. Morel

Territorial behaviour seems to become less conspicuous soon after hatching, as shown by our 1955 dummy experiments. Aggressiveness still persists against intruders, but both parents are so busy gathering food that they have little occasion to spend much time near their nests. Nest-sanitation has been noted only during the week following hatching. Later on droppings are no longer removed and accumulate in the bottom of the nest.

The young were first observed to leave the nest on their 14th day, both in the nesting colonies and in our aviaries. By that time their food consists almost entirely of grass seeds, which they still beg from their parents for at least five days. In the meantime they start foraging on their own, dropping down to the ground underneath the trees and picking up seeds, and even eggshell according to Disney and Haylock's observations made in Tanganyika. In November 1956, fledgelings had not yet left the Hassi Leben colony 19 days after hatching (J. H. Crook, personal communication). When they have abandoned their nest, the juveniles continue to roost for a few days beside it. Later they concentrate together at night, and finally leave the nesting site to roost elsewhere some five days after climbing out of the nests.

Females are ready to breed at the age of one year. Two of our marked birds (white and violet) hatched in our aviaries on September 5, 1955, successfully paired and laid their first eggs in October 1956.

The sex-ratio of the young *Quelea quelea* appears to be almost equal, as shown by the following figures:

TABLE 2

Sex-ratio of the young

—	Age (days)	Total of young	Males	Females
Tambass colony, 1954 ...	1–2	525	279	246
Lemoileh colony, 1954 ...	1–3	313	159	154
Tambass colony, 1954 ...	8	182	86	96
Dara colony, 1953 ...	14	136	71	65

The average number of young raised is a little over two per nest—Tambass colony, 1954: 2.08 (266 nests); Hassi Leben colony, 1955: 2.7 (614 nests); Hassi Leben colony, 1956: 2.2 (436 nests).

Clutch replacement and Second Brood. On October 8, 1953, at Boul's colony, we removed the whole clutch in 8 nests which were at half their incubation period. No clutch replacement took place. However, it has been assumed that the late (and mostly unsuccessful) colonies, which are met with from time to time, could have been built by birds whose nests had been destroyed by the *Office de Lutte Antiaviaire* (Bird Control Service) earlier in the season. Such could have been the case, for instance, with the small colony established round the 20th of October 1956 near Ross-Bethio, half way between Richard-Toll and Saint-Louis; the season was so much advanced that about two-thirds of the nests were abandoned shortly after laying or even after hatching. Until a large number of breeding birds are banded it will be impossible to be sure of that point.

The possibility of a second brood does nevertheless exist. During our 1956 aviary experiments, a marked pair (green male × white female) raised a first brood (4 eggs, 2 young) in nest 1 in October, and the one-year old female laid a second but unsuccessful clutch of 2 eggs in nest 3 (which had been taken up by her mate) on November 11.

The Adults outside of the Breeding Season. As soon as the nesting period is over, Blackfaced Diochs scatter all over the sunburnt savannahs in parties of at most several hundred birds. These small flocks spend most of their time on the ground, scratching it with their feet and bills, searching for the ripe grass seeds which have then fallen down. When frightened by some unusual noise or movement, they take off abruptly—producing a noise which can be heard at long range—and fly some distance before resuming their foraging.

At noon and during the hottest part of the day, the birds like to rest in thick cover to preen and chatter. The duration of such a midday rest appears to depend on the abundance of food. When it is scarce the diochs are busy feeding most of the day, but when it is plentiful and readily available they spend a lot of time resting in some shaded place. That is what happens, for instance, on the large ricefields near Richard-Toll when the crop is ripe. During December 1954, a huge diurnal roost was thus observed at harvest time in a small wood, at about one mile from the fields as the crow flies. Here the birds used to spend hours every day preening, chattering, bathing nearby, or weaving grass around twigs, or even building mock-nests not exceeding the ring stage.

Feeding activities come to an end late in the afternoon and the small flocks can then be observed everywhere, making for their communal night roost, gathering together in certain places before flying to the roost, where they usually arrive in the last half-hour of daylight.

The location of these huge roosts is about the same every year. They are usually located in acacia trees not very far from water, Blackfaced Diochs liking to drink before going to sleep. During the colder months (December to February) when the night temperature may fall to 15° C., they seem to prefer dense reed-beds which probably provide them better shelter. The birds usually leave the nocturnal roosts as the sun rises, the swarm breaking up into a few dense flocks which fly away in different directions before scattering in smaller parties.

Both male and female appear to spend the night in the same roosts, but an intriguing disproportion of the sex-ratio has been disclosed by our 1954 observations. During that year we examined 3,695 adults killed by blasting in 10 roosts along the Sénégal River. Out of these birds we found only 946 females, i.e. about three males to one female. H. J. de S. Disney and Haylock (1956) have also noted that, especially after nesting, flocks may consist almost entirely of males.

Anyway that is a very perplexing problem, as one considers that the sex-ratio among nestlings has always been found to be equal.

The huge bird-clouds on migration reported from East Africa have not been reliably observed in Sénégal or Mauretania up to the present time. Our ringing experiments seem to prove that the birds born in our area stay there and do not wander very far. Out of 970 immature birds banded in Richard-Toll between April and August 1954, 80 were recaptured later at the same place. One young banded early in April was nevertheless found near Dakar (at 250 km. SW. as the crow flies) early in July.

Flocks of juveniles do not seem to merge with adult parties immediately after the breeding season, and for some months the young of the year keep together. Such gatherings are very common around Richard-Toll during the last months of the year. Out of 5,520 birds banded at our station between November 13 and December 26, 1956, no more than 15 were adults.

About a fortnight before breeding the birds start gathering around their usual nesting place. That is the time where unsustained attempts at nesting are reported every year in Lake R'Kiz area.

QUELEA AND ITS ENVIRONMENT

The Blackfaced Dioch seems to be influenced in many ways by the fluctuations of some environmental conditions. Early in the course of this study, we were impressed by the fact that not only were the time and duration of the breeding season obviously related to the timing of the rains, but also that the productivity of the colonies was in some way adjusted to the carrying capacity of the environment. The quantitative study of these interrelations therefore became the main long-term objective of our field observations and of our experimental work. It will probably take us many more years to reach the stage where definite conclusions can be drawn, but some of our preliminary results seem nevertheless worth recording at the present time.

The Timing of the Breeding Season. The various ecological factors which control the breeding cycle of tropical passerines are still very poorly known. As the seasonal variations of the photoperiod are quite small close to the Equator, their influence on the reproductive cycle has been questioned by many ornithologists. On the other hand the effect of the rains cannot be underestimated. We have therefore tried to disentangle the respective influences of these various factors, both by experimentation and by field observations.

That the avian gonads are still able to respond to an artificial increase of daily illumination, at the latitude of Richard-Toll (16° 25′ N.), is shown by our 1955 experiments. From February 2, to June 12, 23 Blackfaced Diochs (11 males and 12 females) were given a daily supplement of light of five hours (from 7 to 12 p.m.). 17 other birds were kept as controls in another aviary and fed, like the experimental animals, on rice and millet. Such an artificial increase of the photoperiod was quickly followed by an increase of the gonads of both sexes, an early appearance of the breeding plumage, and a premature moult of the remiges.

When 12 out of 13 controls had, on June 15, testes which did not exceed 3 mm. in length, 4 'treated' males had testes ranging between 10.5 and 5 mm. and 5 others ranged between 5 and 3 mm.

The black face of the males and yellow bill of the females appeared much earlier in birds which enjoyed a daily supplement of light than among controls. On April 27, for instance, three males had already a perfect black 'mask', when all the controls still kept their sparrowy plumage. On June 12, nine males had their full nuptial dress, as compared with a single control bird.

J. J. Marshall and H. J. de S. Disney have reported very similar results during their work on *Quelea quelea aethiopica*.

An artificial increase of the daily illumination seems, moreover, able to hasten the sexual maturity of young Blackfaced Diochs. On December 8, 1955, one of the young *Quelea* born in our aviaries on September 4, and provided since that time with a daily supplement of five hours of light, already had an half-grown black face!

All these preliminary experiments seem to indicate that the increase in the day-length which takes place from January to June plays a major role in regulating the seasonal enlargement of the gonads of Sénégal's *Quelea*, as it does in passerines nesting much farther north. Once the nuptial plumage is completed and the gonads have attained their full size, the birds are physiologically ready to breed. But actual nest-building does not start at once, nor does it take place at the same time every year. Some more 'proximate' factor must therefore regulate the beginning of the actual nesting season. The rains, in all probability, play this role, more or less directly. Blackfaced Diochs cannot start building their huge nesting colonies before the cover of grass is dense enough to provide them with the tons of material they need to build their millions of nests. Nor can they raise their broods before the insects are abundant enough to compose some 50 per cent of the diet of the young birds. Both the growth of the grass cover and the build-up of a sufficient insect population depend finally on the rains. Until the first showers fall the soil remains barren or covered with straw useless for weaving, and insects are scarce.

No wonder that the *Quelea* nesting season coincides so closely with the rains. Such a correlation becomes obvious when one compares the breeding seasons of the Blackfaced Dioch in West African areas whose rainfall pattern is different. In the upper valley of the Sénégal River (around Matam), for instance, where rains start generally one month earlier than in the Lake R'Kiz area and in the lower valley, nesting likewise begins earlier. In our area the time when actual nest-building takes place varies also from year to year and these variations follow those of the rains. During an average year, like 1953 or 1954, nest-building starts early in September. When the rainy season begins earlier, as in 1955, the birds likewise breed ahead of schedule (nest-building during the second half of August). On the contrary, when the rains are late, as in 1956, the breeding season is postponed and the birds do not start building their colonies till the very end of September.

We still do not know how that rain-stimulus works. We are nevertheless inclined to believe that it acts through its effect on vegetation. Indeed the Blackfaced Diochs never breed immediately after the first rains. On the contrary they seem to wait till new grass is sufficiently grown to enable them to build their nests and to provide them in due time with fresh seeds (and insects) to feed the young.

The Limiting Factors. The factors which control population size in tropical Passerines are still poorly elucidated, and *Quelea quelea* obviously offers an excellent opportunity for such a study.

Food. In years when the rains start very late in the season and are less abundant than usual, thus reducing the amount of food available, both clutch-size and nesting success are smaller than in years when the rainy season is longer and heavier. That was the case in 1956 as compared with 1955 (see tables 1, 3, and 4). The scarcity of broods of more than three fledgelings in such 'bad' years is remarkable, and is quite probably explained by the increased nestling mortality in broods of larger size when the food is not abundant enough. In October 1956 we weighed nestlings at the Palm Grove colony, in nests containing respectively 2, 3 and 4 young. The result is shown in Figures 2 to 4. Not only were the young of larger broods found to weigh rather less when leaving the nest than those from smaller ones, but also the mortality rate in broods of 3 and 4 young was definitely greater than in broods of two. The death of the youngest and weakest nestlings was frequently observed. Furthermore, the fledgelings differed considerably in weight. In nest no. 65, for instance, the larger one weighed 15.9 g. when the smaller reached only 10.5 g. Now, the chances of survival of the fledgelings after leaving the nest are probably very much affected by their weight. Early in December 1956, we were visited in Richard-Toll by large flocks of young birds which had left their nests a few weeks before —some patches of down being still visible on their heads. Those juveniles were obviously starved. Not only was their weight lower than the average, but some were observed gathering around our aviaries and begging for food from our captive adults through the

TABLE 3

Yearly variations in the clutch-size of *Quelea quelea*, Lower Sénégal Valley, 1953–56

Clutch size	1953	1954	1955	1956
1 egg ...	4 (3·1 %)	121 (5·8 %)	59 (4·1 %)	58 (5·9 %)
2 eggs ..	39 (30·7 %)	467 (22·5 %)	194 (13·5 %)	240 (24·6 %)
3 eggs ...	72 (55·9 %)	1228 (59·7 %)	819 (57·3 %)	475 (48·7 %)
4 eggs ...	12 (9·5 %)	230 (11·1 %)	319 (22·3 %)	188 (19.2 %)
5 eggs ...		18 (0·8 %)	37 (2·5 %)	14 (1·4 %)
Nests studied ...	127	2064	1428	975
Average clutch-size...	2·72	2·77	3·06	2·85

wire-netting. Some were found dead around the station and many more (around 10%) died after being trapped for banding, although they were handled carefully and given food and water.

During the next breeding seasons we hope to be able to get quantitative data on the amount of vegetable and insect food available, together with the quantity actually consumed by parents and nestlings. The biomass of available insects will be estimated through the amount collected per night in traps using ultra-violet light.

TABLE 4

Yearly variations in nesting success

R'Kiz area colonies, 1955 and 1956

	1955	1956
Nests with 1 young ...	40 (6.5%)	60 (13.7%)
Nests with 2 young ...	200 (32.5%)	227 (52·0%)
Nests with 3 young ...	277 (45.1%)	146 (33·4%)
Nests with 4 young ...	82 (13.3%)	3 (0·6%)
Nests with 5 young ...	15 (2.4%)	——
Nests examined ...	614	436
Average number of young.	2.7	2.2

Predation. Quelea's predators are rather numerous, but their pressure at the population level does not seem to be very great. During the breeding season we frequently observed Tawny Eagles (*Aquila rapax*) alighting on the nesting trees, tearing open the nests and eating the young. Marabou Storks (*Leptoptilos cruminiferus*) behave much in the same way. The Redbilled Hornbill (*Tockus erythrorhynchus*) is also fond of young Blackfaced Diochs; it easily picks up the nestlings through the nest entrance with its large curved bill. Pythons likewise prey upon the young *Quelea*, as does the Beaked Snake (*Rhamphiopis rostratus*) in East Africa.

Man has undoubtedly now become *Quelea quelea*'s main predator. With the development of modern methods of control (explosives, flame-throwers) millions of adults and nests are destroyed every year. If there is no large exchange of population between the Sénégal Valley and adjacent regions, the species should quickly decrease in numbers in our area.

Longevity in the Wild. Data on the maximum duration of life of the Blackfaced Dioch in captivity are unfortunately still lacking. On the other hand, we have started ringing our birds since too short a time to have any precise idea of their expectation of life in the wild. A few recoveries of birds banded when juveniles nevertheless give a first indication on their maximum longevity.

These preliminary results show that 1.3 per cent at least of the 970 juveniles born during the 1953 season and banded during 1954, still stayed in our study area four years later. Similarly, out of the 228 juveniles of the 1954 season banded in 1955, 2.6 per cent at least were

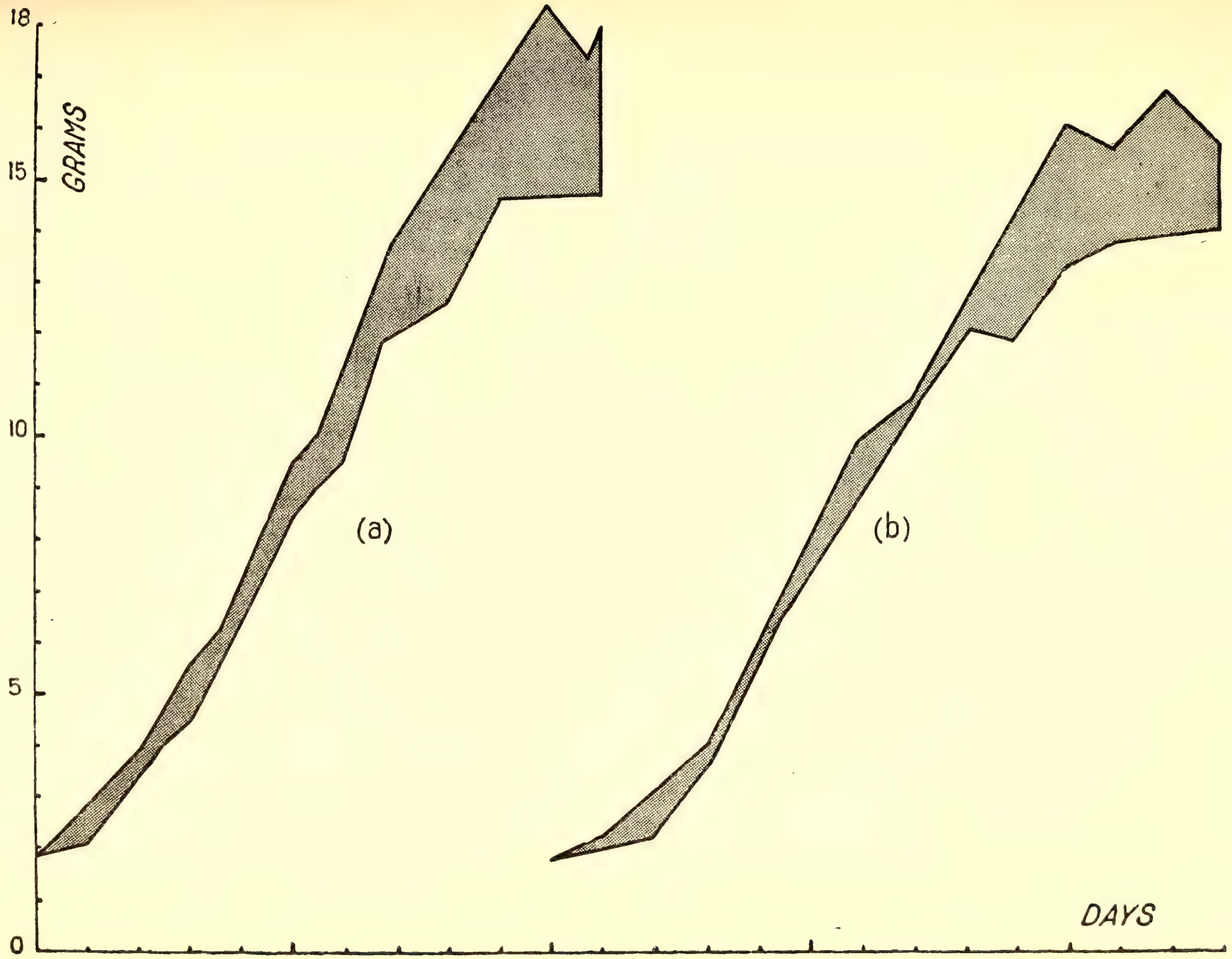


Figure 2.—Growth curves of nestlings in broods of two young, October 1956.

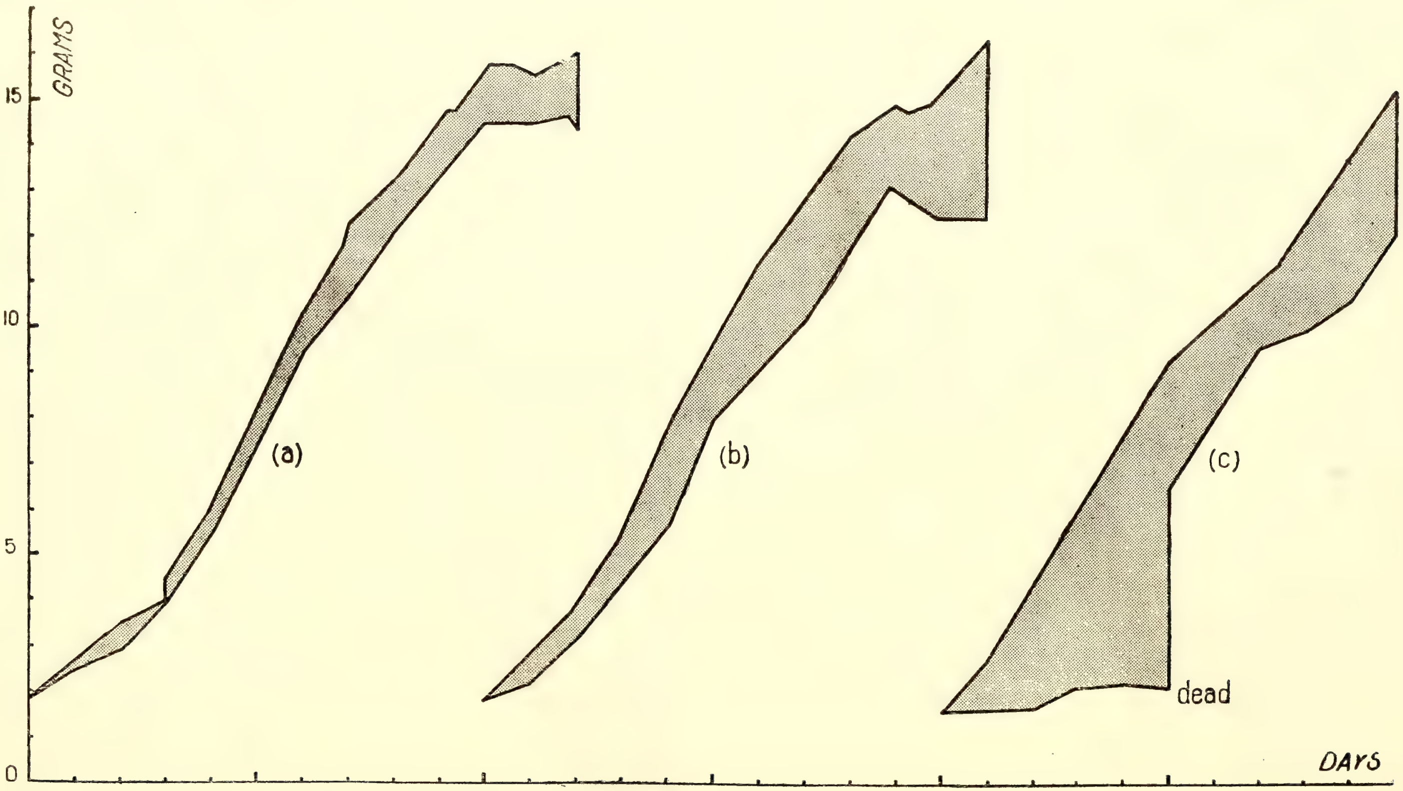


Figure 3.—Growth curves of nestlings in broods of three young, October 1956.

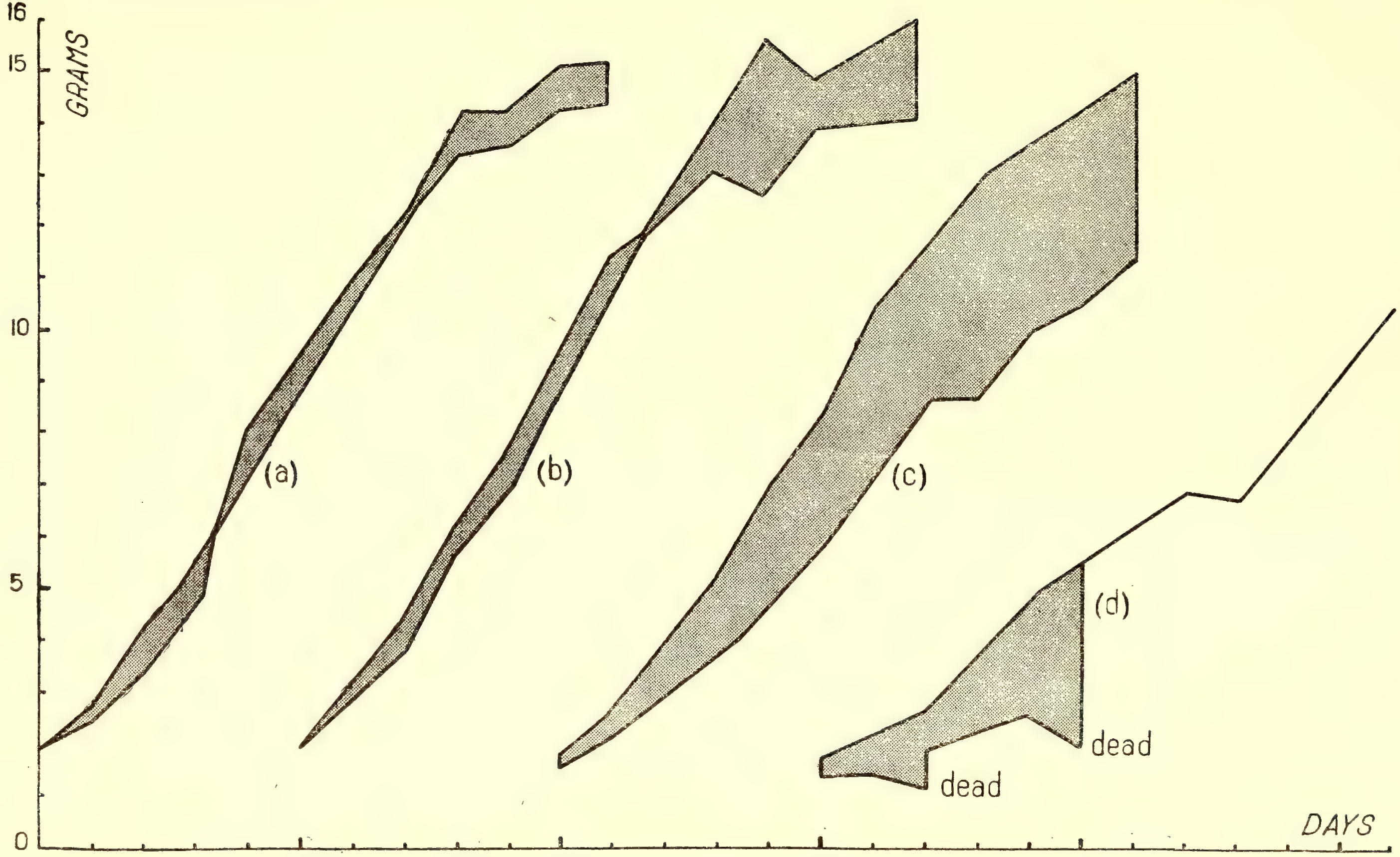


Figure 4.—Growth curves of nestlings in broods of four young, October 1956.

TABLE 5

Longevity of some banded birds.*

No.	Banded on	Recaptured on
HP 7251	28. VI. 1954	26. IV. 1957
HP 7264	28. VI. 1954	28. IV. 1957
HP 7431	7. VII. 1954	10. V. 1957
HP 7483	11. VIII. 1954	11. VI. 1957
HP 7521	12. VIII. 1954	28. IV. 1957
HP 7530	12. VIII. 1954	8. VI. 1957
HP 7714	20. V. 1954	4. VI. 1957
HP 7804	19. VIII. 1954	13. VI. 1957
HP 8028	2. VI. 1954	14. VI. 1957
HP 8057	15. VI. 1954	14. VI. 1957
HP 8073	16. VI. 1954	25. IV. 1957 and 11. V. 1957
HP 8120	18. VI. 1954	26 IV. 1957
HR 9328	23. VIII. 1954	28. IV. 1957, 29. IV. 1957 6. V. 1957, 9. V. and 13. VI.
HR 9491	11. II 1955	11. VI. 1957
HR 9530	3. III. 1955	13. VI. 1957
HR 9596	11. III. 1955	25. IV. 1957
HR 9638	12. IV. 1955	13. VI. 1957
HR 9688	13. V. 1955	4. VI. 1957

still present around the station in 1957. We hope to continue these banding experiments for a sufficient number of years to be able to calculate the rate of disappearance (through mortality and emigration) of the *Quelea quelea* breeding in Lake R'Kiz area.

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* All these birds were banded and recaptured at Richard-Toll.

BIONOMICS OF FORAGE FISHES: OBSERVATIONS ON THE FECUNDITY OF THREE COMMON SPECIES OF MINOR BARBELS

BY

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(*With one figure*)

INTRODUCTION

Carp culture is prevalent in most countries of south-east Asia and several cultural practices calculated to augment fish production have been developed. Culture of predatory fishes, however, appears to have been comparatively neglected. In India, the murrels (*Ophicephalus* spp.) form a group of highly prized, predatory food fishes which are popular in several areas, particularly in the Deccan; but, unlike carps, cultural practices for murrels have yet to be developed on proper lines. A few early attempts made in this direction have not been encouraging (Hora, 1945.) A critical study of these early attempts reveals that hardly any attention was paid to provide adequate natural food for the murrels which are markedly piscivorous in feeding habit. Providing adequate natural forage is essential to ensure satisfactory growth of the predator, and in all field attempts in this line the forage fish will have to be reared in ponds. Detailed information on the bionomics of the various indigenous species of forage fishes is essential if murrels are to be reared in ponds on a large scale and if a forage fish-predator relationship on the lines of the sunfish—Bass combination (Swingle and Smith, 1943) is to be worked out for the murrels. According to Hora (op. cit.) 'unless a similar association of murrel and of another rapidly multiplying fish is established for Indian waters, it will be, in my opinion, a waste of time to culture murrels in ordinary tanks'.

Of the various genera of indigenous carps, the genus *Puntius*, comprising several small size species, deserves consideration as suitable forage fishes. While some preliminary information on the food of nine species of *Puntius* from Madras has been given by Chacko (1948) and certain stray observations on the breeding season of and number of eggs produced by a few species have been recorded by Jones (1946), Innes (1935), Mellen and Lanier (1935), and Stoye (1935), hardly any systematic study of the fecundity of any of these species has yet been made. Since reliable information on the fecundity of a species is essential for regulating its population under cultural conditions and thereby maintaining the desired forage-predator ratio, an attempt has been made in this communication to furnish details of the fecundity of three of the common and widely distributed species of the genus *Puntius*, viz.: *P. stigma*, *P. ticto* and *P. vittatus*.

MATERIAL AND METHODS

Specimens of *P. stigma* and *P. ticto* were obtained from fishery waters at Cuttack, Orissa, while *P. vittatus* was collected from Azhikode, Travancore-Cochin. Fifteen specimens of each species were studied in detail for fecundity counts, while a much larger number was examined for observations on distinguishing characters of sexes, etc. For fecundity counts, after the specimens were measured and weighed, the ovaries were carefully dissected out, weighed, volume obtained by the displacement method, and then samples of known volume were taken for actual counts. In the case of *P. stigma* ova counts were made by the gravimetric method also—counting the number of ova in a sample of known weight—and in five selected specimens the results of the two counts were checked by actual total counts with a view to ascertain the extent of error in the estimations. In *P. vittatus* the ovaries were very small and hence total counts of ova were made in all the specimens.

1. **Puntius stigma** (Valenciennes)

The material for the present study comprised 92 specimens, consisting of 40 males and 52 females. The range of size and weight of specimens of the two sexes are given in Table I.

TABLE I

Length and weight of ripe male and female specimens of the three species of *Puntius*

Species	Sex	No. Examined	Total length (mm.)		Average weight (gms.)
			Range	Average	
P. stigma ..	Male ...	40	45·0– 62·0	56·0	2·68
	Female ...	52	62·0–134·0	81·7	10·24
P. ticto ...	Male ...	15	49·0– 62·0	53·0	2·38
	Female ...	17	57·0– 66·0	61·0	4·33
P. vittatus ...	Male ...	24	21·0– 31·0	26·0	0·22
	Female ...	45	22·0– 46·0	30·5	0·37

Males are thus decidedly smaller than the females. The smallest mature male specimen encountered during this study measured only 45·0 mm. in total length, while the corresponding female specimen measured 62·0 mm.

Besides the disparity in the maturity sizes of the two sexes there are other characters which distinguish the ripe male from the ripe female. Such distinguishing features may be tabulated as follows :

TABLE II

Distinguishing features of ripe male and female specimens of *Puntius stigma*

Distinguishing features		Male	Female
Fins	Dorsal	Pale yellow ...	Tinged pale yellow.
	Others	Yellow ...	Bright red or pink.
Lateral scales along the shoulder region		Golden yellow ...	Silvery.

In immature specimens of both sexes 40·0 to 50·5 mm. long, the fins are dull or pale white in colour, and the golden red opercle spot and the scarlet pink lateral band are wanting.

Fecundity Enumeration: While volumetric as well as gravimetric methods were adopted in the case of 15 specimens of *Puntius*

TABLE III

FECUNDITY COUNT AND SIZE OF OVA IN THE THREE SPECIES OF THE GENUS *Puntius*

Species	Number examined	Total length (mm.)	Weight of fish (gms.)	Weight of ovaries (gms.)	Volume of ovaries (cc.)	Number of ova by			Diameter of ova
						Volumetric method	Gravimetric method	Total count	
Puntius stigma ...	1	78·0	7·46	1·15	1·1	5,060	4,756	5,271	0·62–0·69 (0·65)
	1	79·0	8·07	1·16	1·1	5,720	5,826	5,945	0·59–0·66 (0·62)
	1	80·0	7·93	1·58	1·6	7 648	7,817	7,609	0·62–0·73 (0·66)
	1	90·0	12·01	1·19	1·1	6,869	6,019	...	0·56–0·66 (0·62)
	2	103·0	16·17–18·71 (17·44)	2·18–3·12 (2·65)	1·9–3·0 (2·45)	6,612–17,540 (12,076)	6,830–13,714 (10,276)	...	0·60–0·70 (0·65)
	2	104·0	16·95–18·25 (17·60)	1·65–2·54 (2·09)	1·5–2·4 (1·9)	5,250–8,184 (6,217)	6,941–10,115 (8,528)	...	0·62–0·70 (0·66)
	1	104·0	18·80	2·73	2·9	13,601	14,918	15,106	0·62–0·70 (0·65)
	2	105·0	17·65–18·92 (18·28)	2·29–1·56 (1·92)	1·9–1·4 (1·65)	5,671–6,137 (5,904)	5,243–6,992 (6,117)	...	0.58–0·68 (0·64)
	2	106·0	17·51–19·63 (18·57)	0·87–2·51 (1·69)	0·8–2·3 (1·5)	3,416–15,341 (9,378)	3,350–10,271 (6,810)	...	0·59–0·72 (0·66)
	1	109·0	19·97	2·19	2·1	8,967	10,184	...	0·62–0·69 (0·65)
	1	134·0	44·72	9·95	9·0	47 830	62,323	53,439	0·61–0·72 (0·67)

Puntius ticto ...	1	57·0	3·33	0·68	0·6	3,294	...	...	0·58–0·73 (0·68)
	1	59·0	3·53	0·69	0·7	3,404	...	...	0·64–0·75 (0·69)
	3	60·0	3·46–4·45 (3·89)	0·66–1·00 (0·82)	0·5–1·0 (0·73)	2,688–4.890 (3,707)	...	...	0·69–0·85 (0·77)
	3	61·0	4·11–4·47 (4·24)	0·89–0·93 (0·90)	0·8–0·9 (0·86)	2,368–8,550 (5103)	...	...	0·57–0·72 (0·65)
	2	62·0	3·87–4·23 (4·05)	0·59–0·91 (0·75)	0·5–0·9 (0·70)	3,655–5,148 (4,401)	...	...	0·50–0·70 (0·66)
	3	64·0	4·59–5·07 (4·85)	0·95–1·19 (1·07)	0·8–1·0 (0·93)	4,923–8,590 (6,461)	...	...	0·61–0·79 (0·67)
	1	65·0	5·41	1·27	1·0	4,413	...	...	0·67–0·87 (0·78)
	1	66·0	5·03	0·75	0·6	2,940	...	...	0·64–0·76 (0·70)
Puntius vittatus ...	5	33·0	0·36–0·42 0·38)	0·01–0·03 (0·02)	...	...	...	26–134 (91)	0·61–0·71 (0·68)
	4	34·0	0·37–0·49 (0·45)	0·02–0·03 (0·02)	...	...	...	66–112 (96)	0·64–0·79 (0·70)
	3	35·0	0·49–0·53 (0·51)	0·01–0·02 (0·01)	...	...	...	51–126 (99)	0·58–0·76 (0·68)
	1	36·0	0·58	0·02	...	...	...	75	0·58–0·73 (0·67)
	1	37·0	0·60	0·04	...	...	...	204	0·66–0·75 (0·71)
	1	46·0	1·20	0·08	...	...	...	302	0·63–0·72 (0·68)

Where more than one specimen of the same total length are examined their range and average are given.

TABLE III

FECUNDITY COUNT AND SIZE OF OVA IN THE THREE SPECIES OF THE GENUS *Puntius*

Species	Number examined	Total length (mm.)	Weight of fish (gms.)	Weight of ovaries (gms.)	Volume of ovaries (cc.)	Number of ova by			Diameter of ova
						Volumetric method	Gravimetric method	Total count	
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	1	79·0	8·07	1·16	1·1	5,720	5,826	5,945	0·59–0·66 (0 62)
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	2	103·0	16·17–18·71 (17·44)	2·18–3·12 (2·65)	1·9–3·0 (2·45)	6,612–17,540 (12,076)	6,830–13,714 (10,276)	...	0·60–0·70 (0·65)
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	1	104·0	18·80	2·73	2·9	13,601	14,918	15,106	0·62–0·70 (0·65)
	2	105·0	17·65–18·92 (18·28)	2·29–1·56 (1·92)	1·9–1·4 (1·65)	5,671–6,137 (5,904)	5,242–6,992 (6,117)	...	0.58–0·68 (0·64)
	2	106·0	17·51–19·63 (18·57)	0·87–2·51 (1·69)	0·8–2·3 (1·5)	3,416–15,341 (9,378)	3,350–10,271 (6,810)	...	0·59 -0·72 (0·66)
	1	109·0	19·97	2·19	2·1	8,967	10,184	...	0·62–0·69 (0·65)
	1	134·0	44·72	9·95	9·0	47 830	62,323	53,439	0·61–0·72 (0·67)
Puntius ticto ...	1	57·0	3·33	0·68	0·6	3,294	...	...	0·58–0·73 (0·68)
	1	59·0	3·53	0·69	0·7	3,404	...	...	0·64–0·75 (0·69)
	3	60·0	3·46–4·45 (3 89)	0·66–1·00 (0·82)	0·5–1·0 (0·73)	2,688–4,890 (3,707)	...	...	0·69–0·85 (0·77)
	3	61·0	4·11–4·47 (4·24)	0·89–0·93 (0·90)	0·8–0·9 (0·86)	2,368–8,550 (5103)	...	...	0·57–0·72 (0·65)
	2	62·0	3·87–4·23 (4·05)	0·59–0·91 (0·75)	0·5–0·9 (0·70)	3,655–5,148 (4,401)	...	...	0·50–0·70 (0·66)
	3	64·0	4·59–5·07 (4·85)	0·95–1 19 (1·07)	0·8–1·0 (0·93)	4,923–8,590 (6,461)	...	...	0·61–0·79 (0·67)
	1	65·0	5·41	1·27	1·0	4,413	...	...	0·67–0·87 (0·78)
	1	66·0	5·03	0·75	0·6	2,940	...	...	0·64–0·76 (0·70)
Puntius vittatus ...	5	33·0	0·36–0·42 0·38)	0·01–0·03 (0·02)	...	...	...	26–134 (91)	0·61–0·71 (0·68)
	4	34·0	0·37–0·49 (0·45)	0·02–0·03 (0·02)	...	...	...	66–112 (96)	0·64–0·79 (0·70)
	3	35·0	0·49–0·53 (0·51)	0·01–0·02 (0·01)	...	...	...	51–126 (99)	0·58–0·76 (0·68)
	1	36·0	0·58	0·02	...	...	...	75	0·58–0·73 (0·67)
	1	37·0	0·60	0·04	...	...	...	204	0·66–0·75 (0·71)
	1	46·0	1·20	0·08	...	...	...	302	0·63–0·72 (0·68)

Where more than one specimen of the same total length are examined their range and average are given.

stigma, five of these were studied in detail by the total count method with a view to finding out the extent of error in the estimations. The results are given in Table III.

The total number of eggs produced could generally be stated to increase with the size of the fish. The range of variation in the counts and estimates of ova are as follows :

	Percentage of error by	
Specimen Number	Gravimetric method	Volumetric method
1	− 9·7	−4·0
2	− 2·0	−3·7
3	+ 2·7	+0·5
9	− 1·2	−9·9
15	+ 16·6	−6·7

It can be seen from the above that the percentage of error by the gravimetric method averages +1·28 and by the volumetric method −4·76 in the specimens studied. The amplitude of variation in the percentage of error by the gravimetric method is rather high from an underestimate of 9·7% to an overestimate of 16·6%. By the volumetric method the amplitude of error is much less, being almost invariably an underestimate of 3·7 to 9·9%.

The number of ova produced in terms of the weight of the fish and the weight and volume of ovaries are given in Table IV.

While no regular trend is indicated in the production of ova in respect of the length or weight of fish it is seen that in the biggest specimen there is no indication of any decrease in fecundity and that in the smaller specimens measuring 78 to 80 mm. long, the fecundity in terms of the number of ova per unit weight of the body is also relatively higher. The total number of ova produced by each fish is rather small when compared with larger fishes, but in terms of the weight of the fish or weight of ovaries, the number of ova produced is indeed large. The egg is a little over 0·5 mm. in diameter and rarely bigger than 0·75 mm.

2. **Puntius ticto** Hamilton

32 specimens of *P. ticto* were available for study (Table I). In this species also the males appear to be smaller than the females, but the disparity between the two sexes is not as marked as in *P. stigma*. As an adequate number of specimens has not been examined, further generalisations do not appear warranted.

The fecundity of 15 ripe female specimens was studied by the displacement method and the data are given in Table III.

The number of eggs produced per fish is much less than in *P. stigma*, the maximum number found being 8,590 in a 64·0 mm. long specimen and the minimum of 2,368 ova in a specimen 61·0 mm. long. The average for the 15 specimens of the three species works out as in Table V.

From these figures it would appear that in this species the fecundity is high in specimens 61 to 64 mm. long and tends to decrease in smaller as well as larger specimens. Unless more specimens are studied this observation cannot be confirmed.

The fecundity expressed in terms of the weight of the fish and weight and volume of the ovaries is given in Table IV.

Fluctuations in the number of ova produced per unit body weight and unit weight of ovaries are represented in Fig. I. In both these the maximum is attained in specimens 64 mm. long and the decrease is

TABLE IV

FECUNDITY OF THE THREE SPECIES OF *Puntius* IN TERMS OF WEIGHT OF OVARIES AND BODY WEIGHT

Species	Total length of fish (mm.)	Weight of ovaries in total weight of fish	Number of ova produced		
			Per unit weight of fish (gms.)	Per unit weight of ovaries (gms.)	Per unit volume of ovaries (c.c.)
Puntius stigma ...	78·0	6·48	678	4,400	4,600
	79·0	6·95	708	4,931	5,200
	80·0	5·02	964	4,840	4,780
	90·0	10·09	527	5,772	6,244
	103·0	6·71	673	4,328	4,664
	104·0	8·07	494	3,795	3,867
	105·0	9·90	323	3,303	3,685
	106·0	13·90	489	5,019	5,470
	109·0	9·10	449	4,095	4,270
	134·0	4·50	1,114	5,008	5,535
Puntius ticto ...	57·0	4·90	989	4,844	5,490
	59·0	5·10	964	4,933	4,863
	60·0	5·70	953	4,522	5,080
	61·0	4·60	1,204	5,608	5,868
	62·0	5·40	1,087	5,736	6,289
	64·0	4·50	1,321	5,946	6,905
	65·0	4·30	816	3,475	4,143
	66·0	6·70	585	3,920	4,900
Puntius vittatus ..	33·0	16·5	91	240	3,957
	34·0	19·5	96	213	4,174
	35·0	30·0	99	194	5,824
	36·0	29·0	75	129	3,750
	37·0	15·0	204	340	5,100
	46·0	15·0	302	252	3,775

marked beyond that size. There is thus a clear indication that fecundity declines after a particular size. This has a vital bearing on the selection of breeders for production purposes, but it is necessary to examine a much larger number of specimens before the present observations are confirmed.

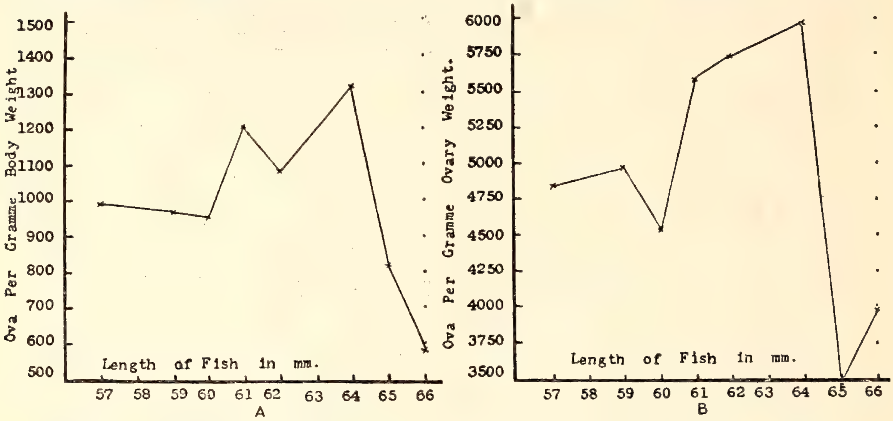

FIG. 1. Fecundity of *P. ticto* in terms of (A) Body weight (B) Ovary weight

3. **Puntius vittatus** Day

This is the smallest of the three species and the largest specimen in the present collection measures only 46 mm. in total length. 69 mature specimens were examined (Table I).

15 bigger female specimens, 33 to 46 mm. long were selected for fecundity counts. As the ovaries were small total count of ova was made in all the 15 specimens and the data are given in Table III.

The total number of eggs produced per fish is very small compared to the two foregoing species. The ova are also fairly large for the size of the fish. The average fecundity figures for the 15 specimens are given in Table V, and the average fecundity figures per gramme body weight of fish and ovaries are given in Table IV.

Smaller mature female specimens were not examined. Unlike the condition in *P. ticto*, within the range of size studied there does not seem to be any indication of a definite fall in the fecundity at any particular size. Probably a clearer picture might emerge when a larger series of specimens are studied.

DISCUSSION

The fecundity data of the three species are summarised in Table V for comparison:

TABLE V

Species	Range of length (mm.)	Average weight (gms.)	Total No. of ova produced		Average No. of ova per gm. body wt.	Average diameter of ovum
			Range	Average		
P. stigma ...	78·0–134·0	17·50	3,416–53,139	11,424	646	0·65 mm.
P. ticto ...	57·0– 66·0	4·29	2,368– 8,590	4,570	990	0·70 mm.
P. vittatus ...	33·0– 46·0	0·51	26– 302	116	228	0·69 mm.

It is seen that the total number of eggs produced in *P. stigma* is quite large, while in *P. vittatus* it is very small. However, when the ova produced are evaluated in terms of the weight of the fish, the fecundity of *P. ticto* is seen to be 1·5 times that of *P. stigma*. On the same basis *P. vittatus* produces only about one-third of the number produced by *P. stigma*.

Puntius conchonius is reported to lay 150 to 600 eggs (Mellen and Lanier 1935; Stoye 1935). It is of almost the same size as *P. ticto*, which is reported to lay 150 to 300 eggs only (Mellen and Lanier 1935; Stoye 1935). 50 to 250 eggs are laid by *P. vittatus* (Jones 1946). These numbers, excepting that of *P. vittatus*, are far too small when compared with the fecundity of *P. stigma* and *P. ticto*. One possible explanation may be that all the eggs in the ovary are not laid at a time, but the number reported to be laid by *P. vittatus* is almost as high as its fecundity figures. This would indicate that at least in this species the eggs are probably laid in one batch.

The average diameter of the egg in *P. stigma* is smaller than that of both *P. ticto* and *P. vittatus*. The latter two are smaller species than *P. stigma*. *P. vittatus* is very much smaller than either *P. stigma* or *P. ticto*, but its eggs are almost as large as those of *P. ticto*. For this relatively small-sized fish the diameter of the egg (0·69 mm.) is fairly large.

The number of ova produced per unit weight of the body in some other freshwater fishes is given below, including the data on the present three species, for comparison.

TABLE VI

Species	Range of length (mm.)	Average wt. of fish (gms.)	No. of ova per gm. body weight	References
Ophicephalus striatus ...	234·0–448·0	342·0	27	Alikunhi, 1953.
Catla catla ...	...	5,207·5	78	Hamid Khan, 1934. Alikunhi, 1965.
Labeo rohita ...	...	4,653·5	409	Do.
Labeo calbasu ...	...	1,816·0	409	Do.
Cirrhina mrigala ...	...	1,475·5	147	Do.
Labeo bata ...	209·0–425·4	187·0	331	Alikunhi, 1956.
Chela phulo ...	61·0– 75·0	2·36	853	Alikunhi and Chaudhuri, 1954.
Puntius stigma ...	78·0–134·0	17·5	646	...
Puntius ticto ...	57·0– 66·0	4·29	990	...
Puntius vittatus ..	33·0– 46·0	0·51	228	...

It is seen from the above table that while the fecundity of the predator (murrel) is much lower than that of either the major carps or the carp minnows, the latter group excepting *P. vittatus*, far exceeds the major carps in fecundity. Among the major carps, Rohu and Calbasu appear to have higher fecundity than Catla or Mrigal, but the fecundity of Rohu and Calbasu is not even half that of either *Chela phulo* or *Puntius ticto*. *Puntius ticto* has the highest fecundity and on this basis it is to be preferred to *P. stigma* or *P. vittatus* as a forage fish.

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OBSERVATIONS ON THE FLORA OF KODAIKANAL

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Kodaikanal in the Palni Hills is so well known as a holiday and health resort that there is no need of giving in this paper its detailed geographical and climatic conditions. The area covered in this paper lies between 10° 12′ and 10° 15′ North latitude and 77° 26′ and 77° 33′ East longitude. Kodaikanal proper has an elevation of about 6900 feet and the hills surrounding it rise from 7000 ft. to 8000 ft. From the introduction to Fyson's FLORA OF THE NILGIRI AND PALNI HILL TOPS we gather the following regarding the study of the vegetation of Kodaikanal. The earliest account of the plants of the Palni Hills, published by Robert Wight in 1837 in the *Journal of the Madras Literary and Scientific Society*, probably does not include the plants of Kodaikanal proper because he does not refer to heights above Shembaganur. Twenty-one years later Colonel Beddome published, in the same journal, a list of 700 plants collected from the Palnis. After that the best collections are those of Sir Alfred and Lady Bourne, and of Fyson. The latter gathered all these data and published his FLORA OF THE NILGIRI AND PALNI HILL TOPS in three volumes. The first two volumes appeared in 1915 and include plants from elevations above 6,500 ft. The third volume appeared in 1920 as a supplement and includes also plants from Coonoor (Nilgiris) and areas down to 5,000 ft. Meanwhile, Gamble's FLORA OF THE MADRAS PRESIDENCY began to appear. This necessitated some changes in the nomenclature in Fyson's Flora. This was done in a revised edition under a new title, THE FLORA OF THE SOUTH INDIAN HILL STATIONS, published in two volumes in 1932 which include also plants from the Yercaud region of the Sheveroy Hills. The first volume describes, with suitable keys, 877 species represented by 429 genera belonging to 116 families. The second volume gives 611 illustrations of the plants described in volume 1. These two volumes are now out of print.

Fyson's Flora is now the only guide for the study of the plants of Kodaikanal. The present writer has been making collections from here off and on, and by constant reference to Fyson's books has found that during the interval between 1932, when it was published, and the present day several changes have taken place in the occurrence and distribution of various plants in these hill-tops. Also, several plants of Kodaikanal are not referred to by Fyson as occurring there. In addition, one or two errors have also been observed in Fyson's descriptions. It is the object of this paper to note down these observations as a help to students of botany visiting Kodaikanal. Kodaikanal also abounds in introduced plants which have now become well established. A separate paper on this topic is under preparation.

The nomenclature followed is the one given by Fyson. After the name of each plant, whenever possible, reference is given to Fyson's

Flora. Thus, for example, *Stephania japonica* Miers. (Fyson 1 : 13 ; 2 : 9) means that this plant is described in Fyson's FLORA OF THE SOUTH INDIAN HILL STATIONS Vol. 1, page 13 and the plant is illustrated in Vol. 2, page 9. The plants collected by me are kept in the herbarium of Loyola College, Madras, and are numbered as JP. . . . .

I take this occasion to thank all those who helped me in my work. In particular I thank the authorities of Loyola College for allowing me to go out for plant collection and for setting me apart for special work in taxonomy. I thank Fr. H. Santapau, S.J., for initiating me into this work, for going through this paper and making valuable corrections and suggestions. Thanks are due in a special way to Prof. B. G. L. Swamy for allowing me to refer to Fyson's collections kept in the Madras Presidency College Herbarium, and for his continuous help and encouragement. I thank the Rector of Sacred Heart College at Shembaganur for allowing me to take the list of the *Eucalyptus* spp. from the paintings kept in the above college museum.

RANUNCULACEAE

Clematis munroana Wt. (Fyson 1 : 3).

For the Palnis it has been recorded for the Shembaganur level about 6,000 ft. I have collected it from the sholas of Kodaikanal proper, about 7.000 ft. (JP 1385).

MENISPERMACEAE

Stephania japonica Miers (Fyson 1: 3; 2: 9).

In Kodaikanal it occurs in the Tiger Shola below Shembaganur, especially after the Parapar bridge. (JP 1754).

CARYOPHYLLACEAE

Polycarpon tetraphyllum Linn. (Fyson 1 : 44 ; 2 : 28).

Its occurrence is not recorded for Kodaikanal. It now grows well as a weed in private gardens and along shaded paths. (JP 1397).

HYPERICACEAE

Hypericum mysorense Heyne (Fyson 1: 46 ; 2 : 29).

It grows abundantly all over Kodaikanal and forms the dominant shrub in all hill-sides. It flowers well in March-April giving a bright yellow hue to the landscape. Its occurrence for Kodaikanal is not mentioned by Fyson. (JP 1346).

Hypericum hookerianum Wt. & Arn. (Fyson 1 : 47 ; 2 : 30).

It is a rare plant in Kodaikanal. Fyson remarks that he has seen it only in the garden of the Observatory. At present this is also found in the compound of Mt. St. Mary and along the stream in the Pambar Shola. Only a few plants are found in each place. (JP 1431).

MALVACEAE

Hibiscus angulosus Masters (Fyson 1: 60; 2 : 40).

Fyson remarks that this plant is quite common on the downs of Palnis. As far as the Kodaikanal region of the Palnis is concerned, this has now become a rare plant. I have been able to locate it only in two places. One is in the Pambar Shola near its edge facing the Levenge path and the second is in the Tiger Shola at the foot of the Silver Cascade and below it along the stream. Only a few plants are found in both places. Rev. Vincent, S.J., a naturalist in Kodaikanal, is growing some of them in his garden in order to preserve them, as he says, from total extinction. (JP 1392).

ELAEOCARPACEAE

Elaeocarpus oblongus Gaertner (Fyson 1 : 65 ; 2 : 41).

Fyson records its occurrence only for the lower limits of the hill station, about 6,000 ft. It is, however, very common in the sholas of Kodaikanal proper, about 7,000 ft. (JP 1425).

Eleocarpus tuberculatus Roxb.

This plant is not mentioned in Fyson. Gamble in his FLORA OF MADRAS PRESIDENCY notes its occurrence in the Western Ghats up to 4,500 ft. This is common in the Tiger Shola below Shembaganur up to 5,500 ft. (JP 1774).

OXALIDACEAE

Oxalis pubescens H. B. & K. (Fyson 1 : 74 ; 2 : 48).

Though very abundant and common in Kodaikanal, its occurrence here is not recorded in Fyson. It grows well in all sholas, especially in well shaded and somewhat moist places. It can also be collected easily from shaded road-sides. (JP 1406).

RHAMNACEAE

Pomaderris lanigera Sims (Fyson 1 : 121 ; 2 : 94).

Fyson records it as 'only where planted'. In Kodaikanal it now grows abundantly as a wild plant in the Pambar Shola, above the path leading to the bridge. (JP 1554).

VITACEAE

Tetrastigma muricatum Gamble (Fyson 1 : 123 ; 2 : 95).

As regards its occurrence, Fyson says : 'Nilgiri and Pulney Hills, below 6,000 ft. common'. The plant, however, has now become common and abundant in the sholas of Kodaikanal, about 7,000 ft. One cannot miss it along the margin of the Bombay Shola, where it forms a green carpet hanging down from the shola trees. It is also common in other sholas and jungles. (JP 1374).

SAPINDACEAE

Allophylus serrulatus Radlk.

This species is not mentioned in Fyson. In Kodaikanal it occurs towards the lower limits of the Tiger Shola, about 5,300 ft. (JP 2365).

Dodonaea viscosa Linn. (Fyson 1 : 128 ; 2 : 100).

For the Palni Hills it is recorded by Fyson as occurring below Kodaikanal. I have collected it from Kodaikanal proper, along the path leading to the Bear Shola (about 6,800 ft.) and along the hill slopes behind the Reservoir (about 7,600 ft.). It is very common in these regions. (JP 1588).

HAMMAMELIDACEAE

Bucklandia populnea R. Br.

An introduced tree, it is now grown as an avenue tree round the Kodaikanal Lake and also in the Sacred Heart College at Shembaganur. (JP 1591).

MYRTACEAE

Eucalyptus :

Species of *Eucalyptus* are now abundant in Kodaikanal both in private compounds and as large areas of cultivated forests. Hence the following information may be of use to those interested in their variety, timber and oil. Large scale introduction of *Eucalyptus* in Kodaikanal was started in 1887 by the Jesuit fathers in their college at Shembaganur in order to clear the marshy malarial tracts around the college. This now forms the Eucalyptus forest of Shembaganur. Later similar forests were planted in Kodaikanal proper, the biggest being the one behind the Observatory. The following 35 species of *Eucalyptus* are found in Kodaikanal. I have not personally collected all these; but the list is prepared from the water colour paintings done by the late Fr. Anglade, S.J., and kept in the Sacred Heart College museum along with his other paintings of the plants of the Palni Hills. The fruits of 33 species (and the timber of 31 species (marked F and T, respectively after their names) are also kept in the above museum. The nomenclature followed is the one given in Von Mueller's EUCALYPTOGRAPHIA.

1. *Eucalyptus acmenoides* Schauer (F, T.)
2. *E. amygdalina* Labill. (F, T.)
3. *E. calophylla* Brown (F, T.)
4. *E. corynocalyx* F. v. M. (F, T.)
5. *E. crebra* F. v. M. (F, T.)
6. *E. diversicolor* F. v. M. (F, T.)
7. *E. eugenioides* Sieber (F, T.)
8. *E. ficifolia* F. v. M. (F, T.)
9. *E. globulus* Labill. (F, T.)
10. *E. gonocalyx* F. v. M. (F, T.)
11. *E. gunnii* J. Hooker (F, T.)
12. *E. haemastoma* Smith (F, T.)
13. *E. hemiphloia* F. v. M. (F, T.)
14. *E. longifolia* Link & Otto (F, T.)

15. *E. maculata* Hooker (F, T.)
16. *E. macrorrhynchia* F. v. M. (F, T.)
17. *E. microcorys* F. v. M. (F, T.)
18. *E. obliqua* l' Heritier (F, T.)
19. *E. paniculata* Smith (F, T.)
20. *E. paucifolia* Sieber (F, T.)
21. *E. pilularis* Smith (F, T.)
22. *E. piperita* Smith (F, T.)
23. *E. punctata* Candolle (F, T.)
24. *E. resinifera* Smith (F, T.)
25. *E. robusta* Smith (F, T.)
26. *E. rostrata* Schlech (F, T.)
27. *E. rudis* Endlicher (F.)
28. *E. saligna* Smith (F, T.)
29. *E. salmoniphloia* F. v. M. (F.)
30. *E. santalifolia* F. v. M.
31. *E. sieberiana* F. v. M. (F, T.)
32. *E. stricta* Sieber
33. *E. stuartiana* F. v. M. (F, T.)
34. *E. tereticornis* Smith (F, T.)
35. *E. viminalis* Labill. (F, T.)

Syzygium arnottianum Walp. (Fyson 1: 219; 2: 167).

This is undoubtedly the commonest and biggest tree in all sholas both for its height and girth. An extraordinarily big specimen is found in the Bombay Shola about a furlong below La Providence. At its base its circumference is 56 ft. and is highly fluted. The interior is a large hollow leaving only about one or two feet of wood and bark on the periphery. The main stem is about 30 ft. high and then it branches into two. The hollow cavity extends from the base to the top of the main stem. I have not succeeded in gathering its flowers and fruit, but its leaves, young and old, clearly indicate its identity.

Syzygium montanum Gamble (Fyson 1: 220; 2: 168).

Fyson does not record its occurrence in Kodaikanal. It can be easily collected from the Bombay Shola, especially below La Providence. (JP 1488).

ONAGRACEAE

Oenothera odorata Jacq. and **Oenothera rosea** Ait. (Fyson 1: 236; 2: 182).

These two plants now occur in Kodaikanal, though not abundantly, in neglected and unweeded gardens. They can be easily collected from the Mt. St. Mary's compound. (JP 1644, 1643).

Fuchsia corymbiflora Ruiz & Pav. (Fyson 1: 237: 2: 183).

Its occurrence in Kodaikanal is not mentioned by Fyson. It grows wild, not abundant, in the Pambar and Bombay Sholas. (JP 1357).

PASSIFLORACEAE

Passiflora calcarata Mast. (Fyson 1: 240; 2: 186).

This now grows wild and abundant along the margin of the sholas, and in jungles and hedges. Its occurrence in Kodaikanal is not recorded by Fyson. (JP 1510).

Passiflora edulis Sims (Fyson 1: 241; 2: 187).

Fyson remarks that this 'has grown wild below Kodaikanal'. In fact, it grows abundantly at and below Shembaganur level. But at present it has also become common in Kodaikanal proper. It can be easily collected from Pambar Shola. (JP 1422).

Passiflora leschenaultii DC. (Fyson 1 : 240; 2: 185).

This is a prominent shola climber. Fyson describes its leaf as glabrous. I have examined the leaves of several specimens collected from different localities in Kodaikanal and in all cases the leaves are found to be prominently hairy. On the lower surface the hairs occur very closely on the veins and veinlets and they lie spreading on the surface giving an ashy-white matted appearance. On the upper surface the hairs are fewer, shorter and distant. De Candolle in his description noted the hairiness of the leaf :— ' subtus in nervis pubescentibus eglandulosis ' (PRODROMUS SYSTEMATIS NATURALIS Vol. III pp. 326). Fyson's and Bourne's plants kept in the Madras Presidency College Herbarium clearly show the hairiness of the leaf. (JP 1384).

Tacsonia mollissima H.B. & K. (Fyson 1: 241; 2: 188).

Fyson observes that this 'is grown in gardens'. At present, in Kodaikanal, it has established itself as a wild plant and forms, in some places, a large shola climber. My attention was first drawn to it by the scattered flowers lying on the floor of the Pambar Shola. Looking up through the binocular I found that it had well established itself on the top layer of the shola trees. It is easily seen in the Bombay Shola, along the Observatory road, etc. (JP).

UMBELLIFERAE

Hydrocotyle conferta Wt. (Fyson 1: 247; 2: 193).

For the Palnis it is recorded as occurring below Kodaikanal. It is, however, well represented in Kodaikanal proper. It grows abundantly in all the sholas. (JP 1408).

RUBIACEAE

Chomelia asiatica O. Kze. (Fyson 1: 279; 2: 227).

For the Palnis it is recorded as occurring in Shembaganur, (6,000 ft.). I have gathered it from Kodaikanal proper where it is common in the Pambar and Bombay Sholas. (JP 1370).

Plectronia ficiformis Gamble

This species is not described in Fyson's Flora. In Kodaikanal it grows as a large tree in the Tiger Shola, about 5,500 ft. (JP 1793).

COMPOSITAE

Eupatorium glandulosum H.B. & K. (Fyson 1 : 316) :

Its occurrence in Kodaikanal is not recorded by Fyson. Though not common, it grows well in the compound of La Providence and by the side of the road near the Government Hospital. (JP 1497).

Helicrisum bracteatum Anders.

This species is not described in Fyson. In Kodaikanal it grows wild in private compounds as well as along some roadsides and is very attractive with its large crown of golden yellow flowers. It can be easily collected from the compound of La Providence. (JP 1565).

Hypochaeris glabra Linn. (Fyson 1 : 340; 2 : 301).

It grows abundantly as a weed in the garden of Mount St. Mary. Fyson does not mention its occurrence in Kodaikanal. (JP 1650).

Galinsoga parviflora Cav. (Fyson 1 : 340; 2 : 284).

Its occurrence in Kodaikanal is not recorded. It grows abundantly in Kodaikanal by the edges of sholas, along paths in sholas and by moist shaded roadsides. It is also abundant in the Tiger Shola about 5,300 ft. (JP 1799).

Spilanthes acmella Linn. (Fyson 1 : 338 ; 2: 281).

It is common by the roadside below Shembaganur to Tiger Shola. (JP 1691).

MYRSINACEAE

Maesa perrottetiana DC. (Fyson 1 : 373 ; 2 : 315).

Its occurrence in Kodaikanal is not recorded by Fyson. It is common in the Tiger Shola. (JP 1702).

ASCLEPIADACEAE

Tylophora mollissima Wt. and **T. tenuis** Bl. (Fyson 1: 398; 2: 336, 337).

The diagrams given in Fyson Vol. 2, pp. 336 and 337 are wrongly labelled. What is labelled as *T. mollissima* Wt. on p. 336 should be *T. tenuis* Bl., and vice versa on p. 337. (JP 1383, 1387).

LOGANIACEAE

Gardneria ovata Wall. (Fyson 1 : 405 ; 2: 344).

Fyson does not record it for Kodaikanal. I have gathered it from the Pambar and Bombay Sholas where it is pretty common. Fyson describes its flower as pentamerous. Actually it is either penta- or tetra-merous. My specimens from Pambar Shola are all tetramerous. (JP 1429).

GENTIANACEAE

Gentiana pedicellata Wall. var. **wightii** Kurz. (Fyson 1 : 409 ; 2 : 349).

Fyson does not mention its occurrence in Kodaikanal. It is found in abundance in all the open grasslands of Kodaikanal. (JP 1451).

SCROPHULARIACEAE

Digitatlis purpurea Linn. (Fyson 1: 429).

Formerly it was very common about Kodaikanal brightening the roadsides with its spikes of pink-red flowers. But the demand for digitalin and the attractive remuneration offered for gathering the plant induced people to dig out entire plants, and so it had become almost extinct except in gardens. Now it is slowly re-establishing itself in its old places. (JP 1992).

LABIATAE

Leucas vestita Benth. (Fyson 1: 482; 2: 420).

Fyson records it only for the lower heights of Kodaikanal, such as Silver Cascade, about 5,500-6,000 ft., and says that it 'is not seen on the higher downs'. I have gathered it from the downs next to Pambar Shola, about 7,000 ft., where it is fairly common. (JP 1446).

AMARANTACEAE

Achyranthes bidentata Bl. (Fyson 1: 487; 2: 426).

For the Palnis, Fyson records it only for Tiger Shola, 5,400 ft. But it occurs commonly in the sholas of Kodaikanal proper, about 7,000 ft. (JP 1418).

LAURACEAE

Cinnamomum wightii Meissn. (Fyson 1: 503; 2 : 437).

Fyson observes that in the Palnis this tree is not seen near Kodaikanal but only at lower levels. It is, however, available in the sholas of Kodaikanal, though not in abundance. It occurs in the Pambar and Bombay Sholas, and stray trees can be found in the small shola above the Park. My plant from Kodaikanal matches well with Fyson's plant (Fyson 2017, 2634) from the Nilgiris, kept in the Madras Presidency College Herbarium. (JP 1589).

Neolitsea zeylanica Merril (Fyson 1: 508 ; 2 : 440).

The genus *Neolitsea* is described as having typically six stamens in the male flower of which the outer four have eglandular filaments and the inner two biglandular filaments. In the female flower there are six staminodes, the outer four eglandular and the inner two biglandular. During my collections in Kodaikanal I observed one tree to show much variation in its stamens and staminodes. This tree occurs in the Bombay Shola along the Violet Lane, about half a furlong below La Providence. About fifty flowers from different branches were analysed and the following variations noted :

(*a*) Some of the female flowers had *eight* staminodes. The outer four were eglandular and filiform, while the inner four were biglandular. Similarly, some male flowers too had *eight* stamens, the outer four with eglandular and the inner four with biglandular filaments.

(*b*) Other flowers, male and female, were seen with *seven* stamens or staminodes respectively. In these there were two types of arrangement. Some had four outer eglandular stamens or staminodes with three inner biglandular ones ; others had three outer eglandular ones, the four inner being biglandular.

(*c*) About 20% of the flowers were of the normal type.

(*d*) As far as I could observe the normal and abnormal flowers did not occur together on the same branch, but only on separate branches.

(*e*) The fruit also showed some variation in size and shape. The normal fruit of *N. zeylanica* is more or less globose and varies from $\frac{1}{3}$-$\frac{1}{2}$ inch in diameter. Fyson remarks that 'a form on the Pulneys has oblong fruits' and refers to Bourne 399. I have not seen Bourne's plant, but the fruits from the tree mentioned here are cylindrical or somewhat oblong, $\frac{1}{2}$ inch long and $\frac{1}{4}$ inch thick, situated in a perianth cup of $\frac{1}{4}$ inch width. (JP 1515).

LORANTHACEAE

Loranthus neelgherrensis Wt. & Arn. (Fyson 1 : 516; 2 : 448).

Fyson does not record it for Kodaikanal. However, it is found in abundance all over Kodaikanal, as an epiphyte, in the margin of sholas, along roadsides and in pear gardens. It is conspicuous by its young scarlet leaves and crimson-coloured axillary umbels. I have observed it growing on the following host plants:

(1) *Viburnum coriaceum* Bl. var. *capitellata* Wt.
(2) Pear trees
(3) *Schefflera racemosa* Harms
(4) *Acacia melanoxylon* R. Br.
(5) *Acacia decurrens* Willd.
(6) *Meliosma wightii* Planch.

EUPHORBIACEAE

Bischofia javanica Bl.

This plant is not described in Fyson's Flora. Gamble, in the FLORA OF MADRAS PRESIDENCY, records it for the Western Ghats in the evergreen forests. In Kodaikanal it can be collected from the lower limits of the Tiger Shola about 5,300 ft. It is not common. (JP 1794).

Euphorbia rothiana Spr. (Fyson 1 : 527 ; 2 : 457).

For the Palnis, Fyson records it only for the lower levels of Kodaikanal. I have seen it growing profusely in the Pambar and Bombay Sholas, about 7,000 ft. (JP 1492).

Glochidion neilgherense Wt. (Fyson 1 : 531 ; 2 : 463).

Fyson records it for levels below Kodaikanal. I have gathered it in Kodaikanal itself from the Bombay Shola along the La Providence Lane. (JP 1494).

ULMACEAE

Celtis wightii Planch. (Fyson 1 : 538 ; 2 : 471).

Fyson does not record it for the Palnis. I have collected it from the Bombay Shola along the La Providence Lane. (JP 1493).

Celtis tetrandra Roxb. (Fyson 1 : 538).

This too is not recorded for the Palnis. It is seen growing well at levels just below Kodaikanal and can easily be collected in the Tiger Shola, about 5,400 ft. It is a large shola tree. (JP 1753).

MORACEAE

Ficus hispida Linn.

This plant is not described in Fyson's Flora. It occurs in the Tiger Shola. (JP 1707).

Morus indica Linn.

Fyson merely remarks that '*M. alba* L. and *M. nigra* L. is frequently planted for its fruit, e.g., at Shembaganur'. (Fyson 1 : 540). My plant is definitely *M. indica* Linn., because the female flower has styles connate below and obovoid sepals. This plant grows wild in the Pambar Shola above the path leading to the bridge and in the Bombay Shola along the lower shola road. (JP 1414).

URTICACEAE

Debregeasia velutina Gaud.

This plant is not described in Fyson's Flora. It grows well below Kodaikanal and can be collected along the Levenge Path in the Shembaganur forest, from the Tiger Shola and near Vilpatti. (JP 1672).

SUMMARY

This paper records the occurrence of, and some notes on, the morphology of some of my plants collected about Kodaikanal. Some of the plants are new records for the area, as they are not recorded by Fyson in his books. Extensive collections are still being made with a view to the preparation of a revised flora of these hills.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE DIATOM GENUS *PINNULARIA*

BY

H. P. GANDHI
Gujarat College, Ahmedabad

(*With twenty-one figures*)

INTRODUCTION

The material for the present paper was collected during the rainy season of 1949, from many millet and paddy fields and road-side pools at Mugad, a place some 9-10 miles away from Dharwar (Mysore State). It was then preserved in 5-6% of commercial formalin. On the author's transfer to the Ismail Yusuf College, Jogeswari, Bombay, the said material was examined in part and the remaining at the Rajaram College, Kolhapur, during 1951-56.

On examination, the collection was found to be very rich in diatoms as can be seen from the number of forms (over sixty) found, in proportion to the area explored. Among these forms, the genera *Pinnularia* and *Hantzschia* appeared to be significant in species. Here the author restricts his paper to describing Pinnularias only, as they occurred in a good number.

For the classification and identification of these forms, Cleve-Euler's (1951-55) monograph is chiefly followed in consultation with Hustedt's (1930) monograph. Here, the preference is given to the former since it has many sections remodelled and a few newly added, besides having a large number of forms described and rearranged. However, the epithets like, ' v. *genuina* ; v. *typica* ; f. *typica* etc. etc.', which refer to the species or variety proper are dropped, being out of vogue.

In all seventeen forms are described in this paper of which two species and four varieties are considered to be new to science and nine, new records for this country.

The dimensions given under each form are those actually recorded.

Genus **Pinnularia** Ehrenberg 1843

Section NODOSAE A. Cl.

1. **Pinnularia acrosphaeria** (Bréb.) W. Sm. f. **undulata** Cleve; Hustedt, *Bacil.*, p. 330. (Fig. 1).
P. acrosphaeria (Bréb) W. Sm. v. *genuina* Cl. f. *undulata* Cl. Cleve-Euler A., *Diat. Schwed. Finn.*—IV, p. 25, fig. 1022 c.

Valves 72-80 μ long and 10-12 μ broad, linear with prominent inflation in the middle and at the broadly rounded ends. Axial area with irregular punctae. Striae 11-12 in 10 μ, thick, very feebly radial in the middle and convergent at the ends.

Distribution in India: Dharwar (Gandhi, 1956): paddy fields and road-side pools.

2. **Pinnularia acrosphaeria** (Bréb.) W. Sm. v. **minor** Cl. ; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 25, fig. 1022 d (Fig. 2.).

Valves 41-54 μ long and 8-9 μ broad, linear, small, very slightly swollen in the middle and at the broadly rounded ends. Striae 12-13 in 10 μ, feebly radial in the middle and parallel or slightly convergent at the ends.

Distribution in India: Dharwar (Gandhi, 1956); Bombay ; Jog-Falls; Kolhapur ; road-side pools and puddles at Mugad.

Section LUNULAE A. Cl.

3. **Pinnularia stomatophoroides** Mayer v. **ornata** A. Cl. f. **erlangensis** Mayer : Cleve-Euler, A., *Diat, Schwed. Finn.*—IV, p. 41, fig. 1053 a, c. (Figs. 3, 13).

Valves 53-77 μ long and 10-12 μ broad, linear or sub-linear with feebly triundulate sides and broadly rounded produced or feebly capitate ends. Raphe thick, subcomplex with unilaterally bent central pores and bayonet-shaped terminal fissures. Axial area 1/4-1/3 the breadth of the valve, sublinear ; central area large, reaching the sides with arcuate row of coarse punctae on either side of the central nodule. Striae 11-13 in 10 μ, thick strongly radial in the middle and convergent at the ends.

Distribution in India : paddy and millet fields at Mugad.

4. **Pinnularia karnatica** sp. nov. (Fig. 4).

[Valvae 62-68 μ longae atque 16-16.5 μ latae, subellipticae, apicibus late-rotundatis. Raphe crassa atque subcomplexa, ornata poris centralibus paulum unilateraliter inclinatis ac fissuris terminalibus crassis et magnis ac falciformibus. Area axialis angusta, linearis ; area centralis ampla usque ad margines perveniens, punctisque crassis ac circa nodulum centralem ordine curvatis, ad aream axialem versus porrecta. Striae 8-9 in 10 μ, crassae, paulum radiales in medio ac convergentes ad apices.]

Valves 62-68 μ long and 16-16.5 μ broad, subelliptical with broadly rounded ends. Raphe thick and subcomplex with central pores slightly unilaterally bent and terminal fissures, thick, large homma-shaped. Axial area narrowly linear: central area large reaching the sides with a curved row of coarse puncta on either side of the central nodule extending towards the axial area. Striae 8-9 in 10 μ, thick, slightly radial in the middle and convergent at the ends.

Distribution in India: paddy fields at Mugad.

This form appears like *P. divergens* W. Sm., as illustrated by McCall (McCall, D., *Diat. Tay Dist.* p. 259, fig. 21 a), in the outline and group of puncta in the central area. However, it differs from it in having puncta in the central area rather well arranged in a curved row and extending towards the axial area. Moreover, the raphe here is thick and subcomplex with broadly curved terminal fissures. It is, therefore, unlike that of *Pinnularia divergens*. Further, with regard to arrangement of puncta in the central and axial areas it resembles *P. stomatophoroides* Mayer and its varieties (Cleve-Euler, op. cit., p. 41, fig. 1053 a-d) and *P. stomātophora* (Grun.) Cl. v. *bergii* A. Cl. (Cleve-Euler, op. cit., p. 42, fig. 1054 e.g), but the present form differs from the said types in the outline, terminal fissures of the raphe and the number of striae. It therefore does not agree with any other known types, hence it is considered to be a new species.

Section DIVERGENTES Cleve

5. **Pinnularia legumen** Ehr. v. **florentina** (Grun.) Cl.; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 51, fig. 1070 c-d (Figs. 5-6, 14).

Valves 55-85 μ long and 12-16 μ broad, linear-lanceolate with triundulate sides and constricted, slightly produced capitate ends. Raphe thin, somewhat undulated with distinct unilaterally bent central pores and broadly curved terminal fissures. Axial area fairly wide, linear; central area large, reaching the sides. Striae 8-11 in 10 μ thick, strongly radial in the middle and convergent at the ends.

Distribution in India: paddy and millet fields at Mugad.

6. **Pinnularia brébissonii** (Kütz.) Cl. v. **producta** A. Cl.; Cleve-Euler. A., *Diat, Schwed. Finn.*—IV, p. 54, fig. 1072 k. (Fig. 15)

Valves 43-54 μ long and 9.8–11 μ broad, narrowly lanceolate with constricted, produced, broadly cuneate or subtruncate ends. Raphe thin with slight undulations, terminal fissures curved. Axial area moderately wide, linear-lanceolate; central area large, reaching the sides. Striae 10-12 in 10 μ thick, closely set, radial in the middle and convergent at the ends.

Distribution in India: paddy and millet fields and road-side pools at Mugad

7. **Pinnularia brébissonii** (Kütz.) Cl. v. **producta** A. Cl. f. **biundulata** (O. Müll.) A. Cl.; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 54, fig. 1072 l, m, o, (Fig. 7).

Pinnularia microstauron (Ehr.) Cl. f. *biundulata* O. Müll.; Hustedt, *Bacil.*, p. 320, fig. 583.

Valves 40-45 μ long and 9-9.5 μ broad, linear-lanceolate, slightly concave in the middle with constricted, broadly produced rounded ends. Raphe thin and slightly undulated with central pores unilaterally bent and terminal fissures curved. Axial area and central area as in the above type. Striae 9-11 in 10 μ, thick, closely set, strongly radial in the middle and convergent at the ends.

Distribution in India: Bombay; paddy and millet fields and road-side pools at Mugad.

8. **Pinnularia microstauron** (Ehr.) Cl. v. **ambigua** Meister; Hustedt. *Bacil.*, p. 320; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 55, fig. 1073 e-f. (Fig. 8).

Valves 46-50 μ long and 7.7-8 μ broad, linear or sublinear with triundulate sides and constricted, broadly produced rounded ends.. Raphe thin, slightly undulated with unilaterally bent central pores and only slightly curved terminal fissures. Axial area narrow, linear; central area very wide, reaching the sides. Striae coarse, 12-13 in 10 μ, strongly radial in the middle and convergent at the ends.

Distribution in India: paddy and millet fields at Mugad.

9. **Pinnularia conica** sp. nov. (Figs. 9-10).

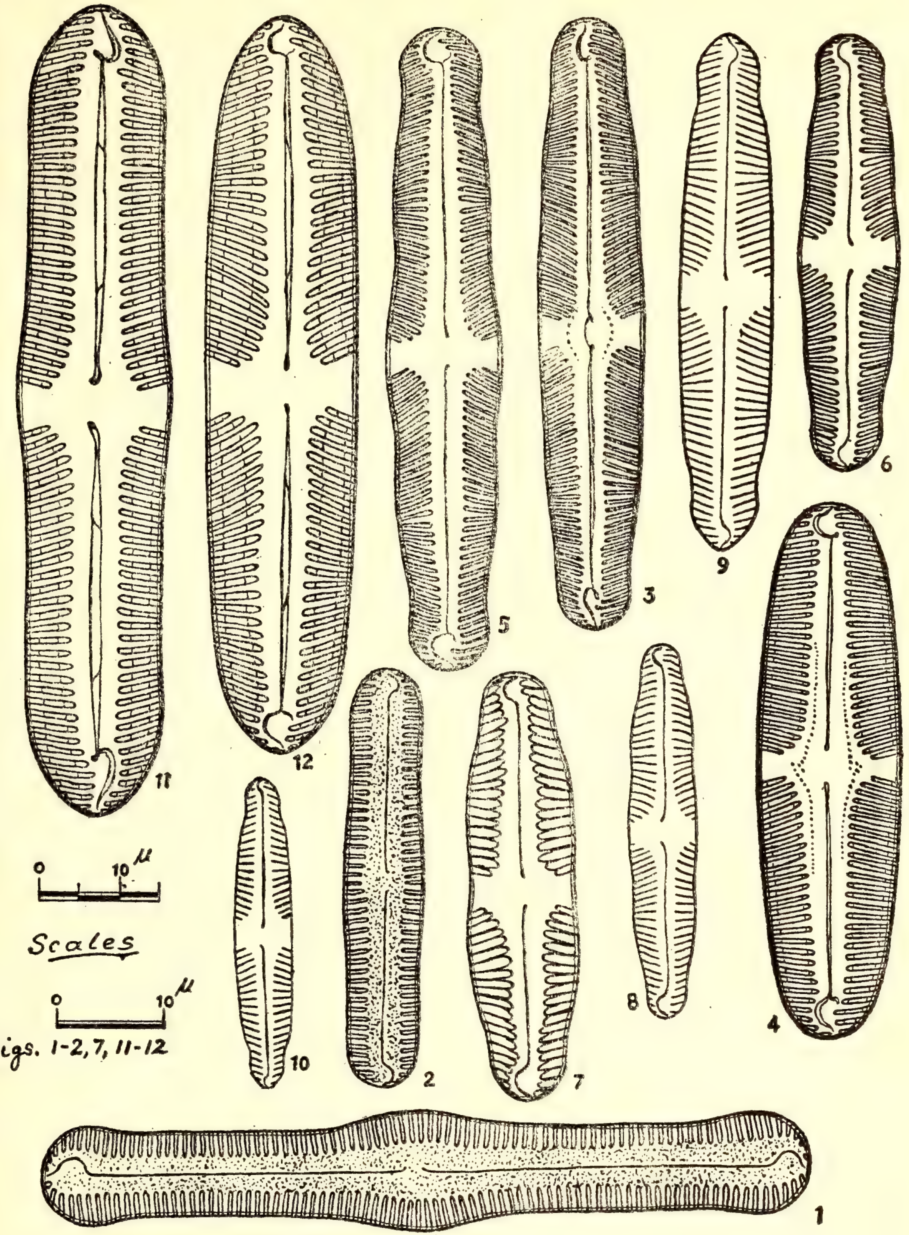
[Valvae 40-63 μ longae atque 7-11 μ latae, lineari-lanceolatae; apicibus constrictis, productis, aliquantum capitatis-cuneatis. Raphe tenuis et recta, ornata poris centralibus distincte atque fissuris terminalibus curvatis. Area axialis angusta 1/5–1/4 latitudinis valvae, linearis; area centralis ampla usque ad margines perveniens. Striae 9-12 in 10 μ, crassae, valde radiales in medio atque in utroque apice convergentes.]

Valves 40-63 μ long and 7-11 μ broad, linear-lanceolate with constricted, produced, slightly capitate-cuneate ends. Raphe thin and straight with distinct central pores and curved terminal fissures. Axial area narrow 1/5–1/4 the breadth of the valve, linear; central area very large reaching the sides. Striae 9–12 in 10 μ, coarse, strongly radial in the middle and convergent at the ends.

Distribution in India: paddy and millet fields and road-side pools at Mugad. Also collected from Bombay; Kolhapur; Dharwar; Jog-Falls; Sagar; Hirebhasgar-dam side and other places.

This form in the first place, resembles *P. braunii* (Grun.) Cl. v. *amphicephala* (A. Mayer) Hust. f. *conica* Venkat., as illustrated by Venkataraman (Venkataraman, *S. I. Diat.*, p. 337, fig. 113), in the outline and produced, slightly capitate-wedge-shaped ends. However, it differs from the said form in the number of striae, greater breadth and dimensions. But the dimensions given for *P. braunii* v. *amphicephala* by Hustedt (Hustedt, *Bacil.*, p. 319, fig. 578), agree well here. Venkataraman, in his remarks on the form states, ' the form resembles in all respects the figure *P. interrupta* f. *braunii* Fritsch (Fritsch, *Ann. S. Afr. Museum*, IX, pt. VII, 1918, p. 592, fig. 40 *a-b*), ' but makes no statement as to in what respect his form differs from Fritsch's that led him to create it as a new form of *P. braunii* v. *amphicephala*. He, in his subsequent paper ' . . Diat. S. India (Government Press Madras) 1956, p. 9, fig. 25', gives a figure of the same form which to my mind is very much like *P. braunii* in the outline and agreeing more or less in the dimensions also (Hustedt, op. cit., p. 319, fig. 577; Cleve-Euler, A., op. cit., p. 24, fig. 1020 a-c, inclusive of the variety *marginata* A. Cl.). However, the striae indicated in his latter form are rather more robust and the area in the centre unilaterally extended. He, in his remarks to this latter form states, ' this form agrees with the type (*Pinnularia braunii* v. *amphicephala* f. *subconica* Venkat.), except for the striae being present on one side in the middle region. This is also broader and shorter than the type. In some specimens striae are continuous while in some others they are *interrupted in one valve* and *not so on one side in the other valve.* These variations also exist in the form described already '. This account given by the author is radically different from what he gave for his original form; neither does he state that he has completely established the identity of the latter specimens with that of his original one by comparison. If this is true that both of his forms are one and the same with indicated range of variations, then my specimens are different. The specimens collected by me from several different localities and areas in Bombay State, do not lend to such variations except for the dimensions, which are within the limits given above.

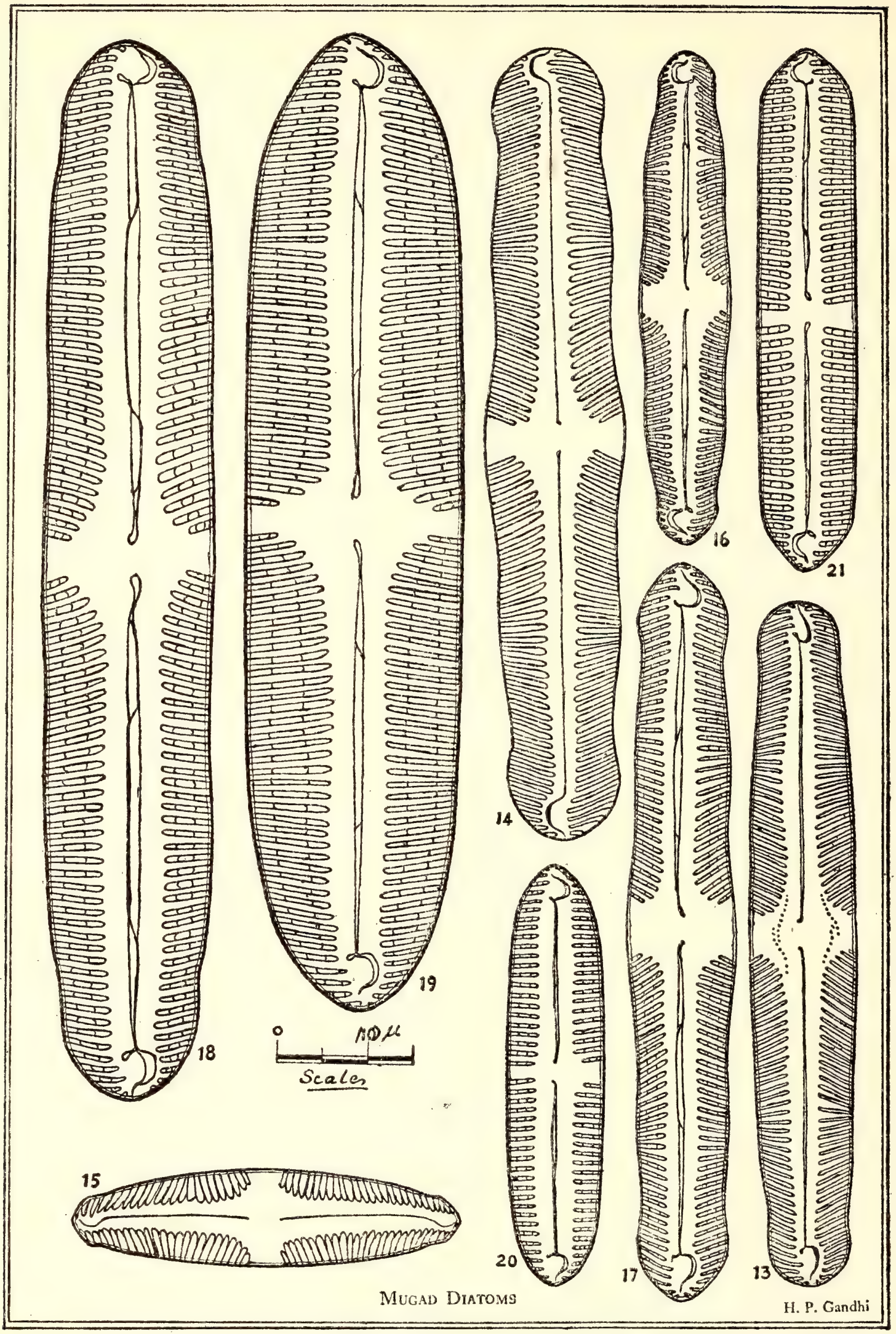
Further, the present form resembles *P. nodosa* Ehr. v. *pseudogracillima* (Mayer) A. Cl., as illustrated by Cleve-Euler (Cleve-Euler, A., op. cit. p. 26, fig. 1024 k, l) and particularly with ' l ', in all respects except for the axial area which in the present specimens is narrow. But the description does not fully accord with the illustration given by the author; nor is it clear if *P. nodosa* v. *pseudogracillima* has or has not scattered punctae in the axial field, characteristic of the main type, but I presume them to be present. In the line following the description of the form, the author



MUGAD DIATOMS

H. P. Gandhi

Fig. 1. *Pinnularia acrosphaeria* (Bréb.) W Sm. f. *undulata* Cl. 2. *Pinnularia acrosphaeria* (Bréb.) W. Sm. v. *minor* Cl. 3. *Pinnularia stomatophoroides* Mayer v. *ornata* A. Cl. f. *erlangensis* Mayer. 4. *Pinnularia karnatica* sp. nov. 5-6. *Pinnularia legumen* Ehr. v. *florentina* (Grun.) Cl. 7. *Pinnularia brébissonii* (Kütz.) Cl. v. *producta* A. Cl. f. *biundulata* (O. Müll.) A. Cl. 8. *Pinnularia microstauron* (Ehr.) Cl. v. *ambigua* Meister. 9-10. *Pinnularia conica* sp. nov. 11. *Pinnularia angustefasciata* A. Cl. 12 *Pinnularia aestuarii* Cl. v *interrupta.* (Hust.) A. Cl.


18
19
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Scale
MUGAD DIATOMS
H. P. Gandhi

Fig. 13. *Pinnularia stomatophoroides* Mayer v. *ornata* A. Cl. f. *erlangensis* Mayer. 14. *Pinnularia legumen* Ehr. v. *florentina* (Grun.) Cl. 15. *Pinnularia brébissonii* (Kütz.) Cl. v. *producta* A. Cl. 16. *Pinnularia esox* Ehr. v. *fasciata* v. nov. 17. *Pinnularia esox* Ehr. v. *capitata* v. nov. 18. *Pinnularia neglecta* (Mayer) A. Berg v. *interrupta* v. nov. 19. *Pinnularia aestuarii* Cl. v. *lata* v. nov. 20. *Pinnularia isostauron* (Ehr.? Grun.) Cl. 21. *Pinnularia isostauron* (Ehr.? Grun.) Cl. v. *conifera* Brun. and Héribaud

mentions that the walls are not undulate and fig. 1024, 1, is like v. *recta* A. Cl.

Taking all these points into consideration, it seems clear that my specimens which do not have any puncta in the axial area, are distinctive. I therefore consider them to be a new species.

Section MAJORES Cleve

10. **Pinnularia esox** Ehr. v. **fasciata** v. nov. (Fig. 16).

[Valvae 55-71 μ longae atque 10.5-11 μ latae, lineari-lanceolatae, marginibus triundulatae; apicibus constrictis, productis-cuneatis vel subcapitatis. Raphe semi-complexa, poris centralibus distinctis et fissuris terminalibus late curvatis. Area axialis ampla 1/4-1/3 latitudinis valvae, lineari-lanceolatae; area centralis amplissima usque ad margines perveniens. Striae 9-11 in 10 μ, crassae, valde radiales in medio ac in utroque apice convergentes, vittis longitudinalibus indistinctis.]

Valves 55-71 μ long and 10.5-11 μ broad, linear-lanceolate with triundulate margins and constricted, produced-cuneate to subcapitate ends. Raphe semi-complex with central pores distinct and terminal fissures broadly curved. Axial area wide 1/4-1/3 the breadth of the valve, linear-lanceolate; central area very large reaching the sides. Striae 9-11 in 10 μ, thick, strongly radial in the middle and convergent at the ends, longitudinal bands indistinct.

Distribution in India: paddy fields at Mugad.

This form closely resembles *P. esox* Ehr., and its varieties as illustrated by Cleve-Euler, (Cleve-Euler, A., op. cit., p. 76, fig. 1107 a-g) and Hustedt (Hustedt, *Bacil.*, p. 334, fig. 616), in the triundulate sides, semi-complex raphe, narrow longitudinal bands etc. However, it differs from it in having broad central area reaching the sides, longitudinal bands somewhat indistinct, besides it is smaller in size. This form also differs from *P. stomatophoroides* Mayer v. *nuda* A. Cl. (Cleve-Euler, op. cit., p. 41, fig. 1053 e, f) and *P. stauroptera* (Rabh.) Cl. v. *longa* A. Cl. (Cleve-Euler, op. cit., p. 67, fig. 1091 g-i) in many respects except for the general outline. Since this form shows a greater affinity to *P. esox* than any other form, it is, therefore, regarded as a new variety of *P. esox*.

11. **Pinnularia esox** Ehr. v. **capitata** v. nov. (Fig. 17).

[Valvae 78-80 μ longae atque 12-13 μ latae, lineari-lanceolatae, marginibus triundulatae, aliquantum dilatatae in medio; apicibus constrictis et capitato-cuneatis. Raphe crassa, semi-complexa, ornata poris centralibus unilateraliter inclinatis, fissuris terminalibus late curvatis. Area axialis 1/4 latitudinis valvae, linearis; area centralis amplissima usque ad margines perveniens. Striae 8-10 in 10 μ, crassae, valde radiales in medio et convergentes ad apices, vittis longitudinalibus indistinctis et angustissimis.]

Valves 78-80 μ long and 12-13 μ broad, linear-lanceolate with triundulate margins, somewhat dilated in the middle with constricted capitate-wedge-shaped ends. Raphe thick and semi-complex with unilaterally bent central pores and broadly curved terminal fissures. Axial area $\frac{1}{4}$ the breadth of the valve, linear; central area very large, reaching the sides. Striae thick, 8-10 in 10 μ, strongly radial in the middle and convergent at the ends, longitudinal bands indistinct and very narrow.

Distribution in India: paddy fields at Mugad.

This form resembles *P. esox* Ehr., as described and illustrated by Hustedt, (Hustedt, *Bacil.*, p. 334, fig. 616) and Cleve-Euler, A. (op. cit. p. 76, fig. 1107 a – b, = *P. esox* v. *clevei* A. Cl.), in the outline, undulated margins, semi-complex raphe and other details. However, it differs from the said type in having distinctly capitate-wedge-shaped ends and very large central area extending to the sides. It also differs from *P. polyonca* (Bréb.) O. Müll., described by Hustedt (Hustedt, op. cit., p. 319, fig. 576), and others, in many details except for the general outline and capitate ends. The present form further differs from *P. divergens* W. Sm. v. *capitata* A. Cl. (Cleve-Euler, op. cit., p. 53, fig. 1071 k), in not having the constriction in the middle as also the thickenings on the walls in the central region, but for the outline. Moreover, the raphe here is sub-complex. It, therefore, appears to be a distinctive form coming closer only to *P. esox*, hence it is considered to be its new variety.

Section COMPLEXAE Cleve

12. **Pinnularia angustefasciata** A. Cl.; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 78, fig. 1109 a-c. (Fig. 11).

Valves 52-87 μ long and 10-15 μ broad, linear with a median inflation and inconspicuously swollen broadly subcuneate ends. Raphe thick and complex with central pores unilaterally bent and terminal fissures somewhat bayonet-shaped. Axial area $\frac{1}{4}$ the breadth of the valve, linear; central area moderately wide, reaching the sides. Striae 8-10 in 10μ thick, slightly radial in the middle and convergent at the ends, longitudinal bands present but indistinct.

Distribution in India: paddy and millet fields at Mugad.

This form agrees well with the type described by Cleve-Euler except that some smaller forms were also recorded from the area. The epithet 'v. *schmidtii* A. Cl.' (= *P. angustefasciata* v *schmidtii* A. Cl.), indicates the main type, hence avoided. This form resembles *P. regina* Mills (Mills, *Diat. from Warri*, p. 394, pl. III, fig. 33), in the outline, raphe, central and axial areas. However, the present form has no punctae either in the central area or in the polar nodules, hence it differs. It further differs from it in dimensions and number of striae.

13. **Pinnularia neglecta** (Mayer) A. Berg v. **interrupta** v. nov. (Fig. 18).

[Valvae 99-116 μ longae atque 17-19·3 μ latae, robustae, lineares, marginibus indistincte triundulatae; apicibus late-productis, subcuneatis et rotundatis. Raphe crassa, valde complexa; ornata poris centralibus crassis ac unilateraliter inclinatis; fissuris terminalibus crassis et curvatis. Area axialis $\frac{1}{4}$-$\frac{1}{3}$ latitudinis valvae, linearis; area centralis ampla usque ad margines perveniens. Striae 7-8 in 10 μ, crassae, radiales in medio ac in utroque apice convergentes, vittis longitudinalibus distinctis et angusta.]

Valves 99-116 μ long 17-19·3 μ broad, robust linear with indistinctly triundulate sides and broadly produced, subcuneate-rounded ends. Raphe thick, strongly complex with central pores thick and unilaterally bent and terminal fissures thick and curved. Axial area $\frac{1}{4}$-$\frac{1}{3}$ the breadth of the valve, linear; central area large, reaching the sides. Striae

7-8 in 10 μ, thick, radial in the middle and convergent at the ends, longitudinal bands distinct but narrow.

Distribution in India: paddy and millet fields and a road-side pool at Mugad.

This form agrees well with the type described by Cleve-Euler (Cleve-Euler, A., op. cit., p. 80, fig. 1112 a-b), except that the central area reaches the sides due to interruption of the median striae. It is therefore regarded as a new variety.

Section VITREATAE A. Berg

14. **Pinnularia aestuarii** Cl. v. **interrupta** (Hust.) A Cl.; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 82, fig. 1115 b-c (Fig. 12)

Valves 67-87 μ long and 14-15 μ broad, linear with broadly sub-cuneate ends. Raphe thick, complex with large central pores unilaterally bent and semi-circular terminal fissures. Axial area $\frac{1}{4}$ the breadth of the valve, linear; central area fairly large, reaching the sides. Striae 8-9 in 10 μ, radial in the middle and convergent at the ends, fairly wide longitudinal shiny bands present.

Distribution in India: paddy and millet fields at Mugad.

This form agrees well with the type described by Cleve-Euler, except that it is slightly broader. It also resembles *P. westii* McCall (McCall, D., *Diat. Tay Dist.*, p. 261, fig. 24), in the outline, dimensions and a few other details. However, the present form has complex raphe and the central pores not at all strongly unilaterally bent, hence it differs from *P. westii* McCall.

15. **Pinnularia aestuarii** Cl. v. **lata** v. nov. (Fig. 19).

[Frustula robusta atque in aspectu zonali late rectangularia. Valvae 87-106 μ longae atque 17-25 μ latae, late-lineares, apicibus subcuneatae rotundatae. Raphe crassa paullum complexa, ornata poris centralibus magnis atque unilateraliter inclinatis et fissuris terminalibus late curvatis. Area axialis angusta, linearis; area centralis angusta usque ad margines perveniens. Striae 7-8 in 10 μ, crassae, aliquantum parallelae, radiales in medio ac convergentes ad apices cum vittis longitudinalibus modico amplis et claris.]

Frustules robust and broadly rectangular in girdle view. Valves 87-106 μ long and 17-25 μ broad, broadly linear with subcuneate rounded ends. Raphe thick and slightly complex with central pores large and unilaterally bent and terminal fissures broadly curved. Axial area narrow, linear; central area narrow, reaching the sides. Striae 7-8 in 10 μ, thick, slightly parallel, radial in the middle and convergent at the ends with fairly broad and clear longitudinal bands.

Distribution in India: paddy and millet fields at Mugadi

This form agrees well with the type *P. aestuarii* Cl. and its variety *interrupta* (Hust.) A. Cl., as described by Cleve-Euler (Cleve-Euler, op. cit., p. 82, fig. 1115 *a-c*), in all respects, except that it is proportionately very broad and the striae somewhat parallel, less radial and convergent than in the type. It does not agree with any other form so closely, hence it is regarded as a new variety of *P. aestuarii*.

16. **Pinnularia isostauron** (Ehr. ? Grun.) Cl.; Skvortzow, B. W., *Diat. from Kaolingtze—Manchoukuo*, p. 354, pl. 1, fig. 19 ; pl. 2, fig. 15. (Fig. 20.).
P. isostauron v. *genuina* A. Cl. ; Cleve-Euler, A., *Diat. Schwed. Finn.*—IV, p. 84, fig. 1116 a-b.

Valves 41-46 μ long and 8·8-10 μ broad, linear with feebly convex sides and broadly subcuneate ends. Raphe thick, complex with distinct and somewhat closely set central pores and broadly curved terminal fissures. Axial area $\frac{1}{3}$ the breadth of the valve, linear; central area reaching the sides and unilaterally wide. Striae 9-10 in 10μ, slightly radial in the middle and convergent at the ends with well marked longitudinal bands.

Distribution in India: paddy and millet fields at Mugad.

17. **Pinnularia isostauron** (Ehr. ? Grun.) Cl. v. **conifera** Brun & Hér. Cleve-Euler, A., *Diat. Schwed. Finn.* IV, p. 84, fig. 1116 c (Fig. 121).

Valves 52-56 μ long and 8-9 μ broad, linear with broadly cuneate rounded ends. Raphe thick, complex with unilaterally bent central pores and semi-circular terminal fissures. Axial area $\frac{1}{4}$-$\frac{1}{3}$ the breadth of the valve, linear; central area reaching the sides but unilaterally wide. Striae 9-10 in 10 μ, thick, slightly radial in the middle and convergent at the ends, longitudinal bands present.

Distribution in India: paddy and millet fields at Mugad.

SUMMARY

In this paper the species of *Pinnularia* from Mugad (Dharwar) are described and illustrated. Many of these forms are interesting and beautiful, and make new records for India and a few for science.

ACKNOWLEDGEMENT

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MATING IN SCORPIONS

BY

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(*With 3 text figures*)

A very interesting observation by Miss Annie Alexander on the mating behaviour of a South African scorpion, *Opisthophthalmus latimanus typicus* C. Koch appeared in *Nature*, Vol. 178, October 1956. A similar observation regarding mating in *Euscorpius* is recorded by Dr. A. Kaestner in LEHRBUCH DER SPEZIELLEN ZOOLOGIE, Teil 1, Jena (1956), as described by Angermann (1955), *Naturwiss.* 42 U and (1956) *Zool. Anz. Suppl.* 19. These observations should lead us to re-examine the classical views on the male reproductive system of scorpion; yet, in an article on the male reproductive system of a scorpion appearing in the March issue of the *Quart. Jour. of Micr. Sc.* (Vol. 98, March, 1957) the author gives an elaborate morphological account of the 'shaft of the ejaculatory organ' often referred to as the 'penis', in full accordance with the old views. Though the classical description of the 'dance' and copulation has been accepted by most writers up to recent times, there was an inherent weakness in those accounts since no one had stated definitely that the actual process of copulation had been observed; and the frequent statement that the anterior part of the 'penis' or 'copulatory organ' is protruded through the genital orifice, was only a guess. Miss Alexander has shown that during the movements usually called the 'dance' the male deposits a spermatophore in front of the female and that the latter in the subsequent movements, sucks up the sperm bundles contained in the spermatophore, into her genital opening, thus concluding that the process of mating in scorpions is similar to what is well known in pseudoscorpions.

MATING BEHAVIOUR IN *Heterometrus scaber* THORELL

In the South Indian scorpion *Heterometrus scaber*, I found that fundamentally the same process takes place with slight variations. A mature male and a female were placed together in a cage. Soon they began paying attention to each other. The dance was a brief one, more or less as described by Miss Alexander, and its 'finale' was the to and fro movements, 'hand in hand' during which the female was brought over the spermatophore, now fixed on the ground, and the sperm mass was sucked up into her genital opening. In these movements the pectines were very active and undoubtedly helped the female to adjust her position bringing the genital orifice just over the opened valves of the spermatophore.

THE SPERMATOPHORE

The spermatophore of *Heterometrus* differs in certain respects from that described by Miss Alexander for *Opisthophthalmus*. Fig. 1 represents a spermatophore of *H. scaber* deposited in front of the female. It consists of two limbs, a vertical limb which is in the form of a broad stem (Fig. 1, A) and a posterior narrow cylindrical limb (Fig. 1, D). At the junction of these limbs is a pair of triangular flaps through which the sperm mass is passed into the vagina of the female (Fig. 1, B).

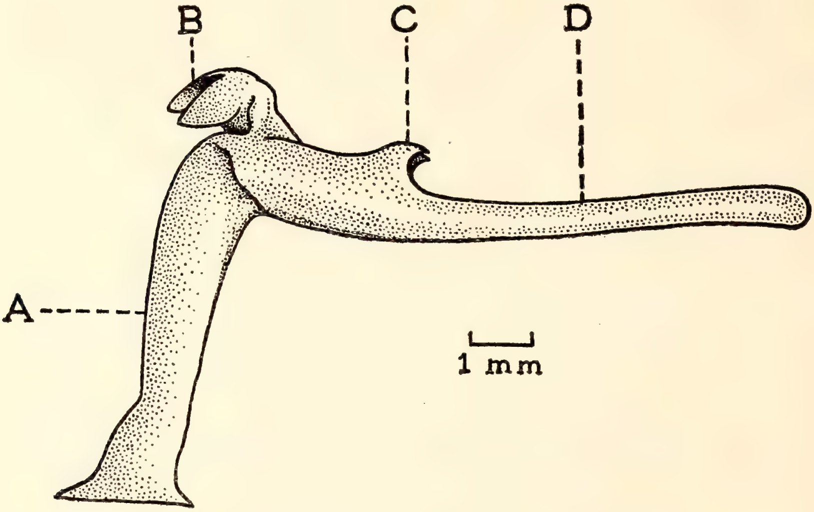

Fig. 1. The spermatophore of *Heterometrus scaber*.
A. Vertical limb. B. Triangular flaps. C. Spines. D. Posterior limb.

The vertical limb is formed of two lateral halves which are semicylindrical and united along its mid-ventral line. It is tipped with a spongy cap apparently of the same substance that is seen as a narrow band along the ventral suture, binding the two halves. This substance extends as a pair of thin expanded 'wings' by which the spermatophore is attached to the ground. The posterior limb is cylindrical but is also formed of two lateral halves fused along the dorsal and ventral lines. Its anterior part is broad, and as it narrows there is a pair of spines directed backwards (Fig. 1, C).

FORMATION OF THE SPERMATOPHORE

To ascertain the origin and morphology of these structures a number of male scorpions were examined. The terminal part of the *vas deferens*, as is usually described, has the following arrangement (Fig. 2).

1. The *vas deferens* opens at the middle of the inner border of the sheath of the copulatory organ (Fig. 2, E).

2. An accessory sac variously named but undoubtedly the seminal vesicle, opens into the terminal part of the *vas deferens*. This sac when filled with sperm bundles appears as a swollen oval structure with a long stalk (Fig. 2, C).

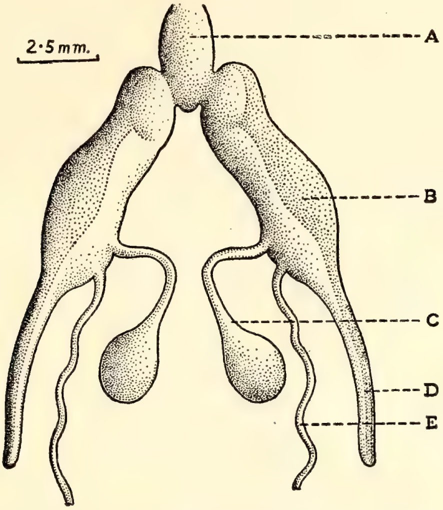

Fig. 2. The terminal part of the male reproductive system of *H. scaber*.
A. Common terminal duct. B. Sheath of the copulatory organ (paraxial organ) ; really the spermatophoral sac. C. Seminal vesicle. D. Narrow hind part of the 'paraxial organ'. E. Proximal end of the *vas deferens*.

3. The sheath of the copulatory organ, sometimes called 'paraxial organ' is a long wide tube (Fig. 2,B). Its wall is glandular and internally it contains a grooved chitinous structure, the 'penis' or 'copulatory organ'. The 'sheaths' of the two sides unite anteriorly and open through a short common duct into the median genital orifice, guarded by the cleft genital operculum. On the ventral wall of this short common duct there is a thick gland—*the ventral accessory gland*. On cutting open the 'sheath' it is seen that the 'penis' is not connected with the wall of the 'sheath' by any musculature but that it is only a secreted product lying inside it. The wall of the 'sheath' is highly glandular and inside the groove of the 'penis' there is a bundle of twisted sperms in a thin gelatinous envelope. If it were a real 'penis' it should be capable of retraction after pairing. But the presence of certain backwardly directed spines clearly shows that such a retraction is not possible.

This so-called 'penis' can easily be pressed out of the sheath and then it is seen to be identical with one of the lateral halves of the spermatophore (Figs. 1 & 3). About the middle of this structure is a hinge-like joint connecting the anterior and posterior regions and just at this joint is a flap-like fold which corresponds to one of the triangular flaps of the spermatophore (Figs. 3, b & 1, B). Behind this is a backwardly directed spine (Fig. 3, c) corresponding to one of the spines at the beginning of the posterior limb of the spermatophore

(Fig. 1, C). During courtship the so-called 'penis' of the two sides are pushed out through the single median pore and as they come out, the edges of the semi-cylindrical grooved structures are glued to form a single 'spermatophore'. The gluing appears to be effected by the secretion of the ventral and dorsal accessory glands.

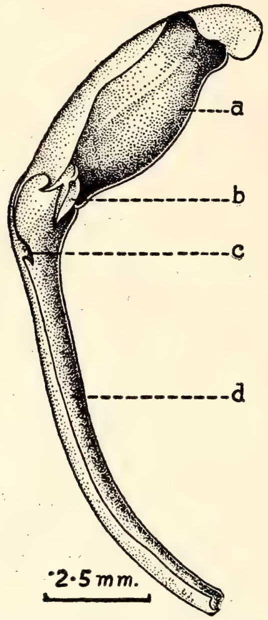

Fig. 3. The 'penis' of one side taken out of its 'sheath'; in reality one of the valves of the spermatophore.

a. anterior limb (becomes vertical limb in the spermatophore). *b*. triangular flap. c. backwardly directed spine. d. posterior limb.

The articulation of the anterior and posterior regions of the spermatophore is such that the posterior part can be flexed at right angles to the stem (anterior part). This movement releases the triangular flaps which are thrust outwards. It is between these everted flaps that the sperm masses are sucked into the female's vagina. This is part of the opening mechanism of the spermatophore. When the female is actually brought astride the spermatophore her body movements pressing on the horizontal or posterior limb bring about the eversion of the triangular flaps and at the same time, this limb working like a lever serves to squeeze the sperm masses between the flaps into the vagina of the female. Once a spermatophore has been discharged by a male, he is incapable of producing another immediately. On dissecting a male which had mated the previous day it was found that the sheaths had shrunk a little and that the chitinous grooved 'penes' were absent. But the twisted bundles of sperms which had formerly filled the seminal vesicle, had passed into the sheath and the vesicles were empty. Another male which had mated four days earlier was placed in a cage with a female. They noticed each other and the male approached the female as in the early stages of courtship. But the female soon became non-responsive and avoided the attentions of the male. The next morning I was surprised to see that the male was killed and eaten by the female. There was no empty spermatophore in the cage. Could it be that this tragedy was because the male had no spermatophore to offer to the female? Repetitions of this experiment, however, did not always confirm the above observation. In many cases it was seen that the male and the female crouched in a corner of the cage without any special reactions for a few days. The sexual condition of the female must be a decisive factor in determining her behaviour under these circumstances.

The above observation would incidentally explain the anomalies noticed in the male reproductive system of scorpions which confused previous workers and render unnecessary the futile attempts to explain these anomalies as due to changes in the different stages of growth, (Pavlovsky, E. *Trav. de la Soc. Imp. Natur. Petrograd*, 1915). The 'shaft' figured in *Quart. Journ. Micr. Sc.* in the article cited above, is evidently an incomplete one in the course of secretion, after a spermatophore has been ejected.

In view of these findings, it will be necessary to name the so-called 'sheath of the copulatory organ' (Fig. 2, B) as the *Spermatophoral sac* and the 'penis' of the sides (Fig. 3) as the right and left *valves of the spermatophore.*

THE GENUS *EREMOPOGON* STAPF AND ITS AFFINITIES WITH *SCHIZACHYRIUM* NEES

BY

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AND

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(*With a plate*)

The name *Eremopogon* was first given by Hackel (1) to a section of his subgenus *Hypogynium* of the genus *Andropogon.* Under this section Hackel described three species, namely, *Andropogon foveolatus* Delile (varieties *genuinus* and *strictus*), *A. tuberculatus* Hack. and *A. delavayi* Hack.

The subgenus *Hypogynium* is characterized by female and unawned sessile spikelets. We are unable to understand the inclusion of section *Eremopogon* in *Hypogynium*, because all the three species kept by Hackel under section *Eremopogon* have hermaphrodite and awned sessile spikelets.

Stapf (2) raised *Eremopogon* to a generic rank, basing his type species *E. foveolatus* (Delile) Stapf on *Andropogon foveolatus* Delile.

EREMOPOGON STAP~~E~~F

Eremopogon (Hack.) Stapf in Fl. Trop. Afr. IX (1917) 182; A. Camus in Ann. Soc. Linn. Lyon. LXVIII (1921) 207; Pilger in Die Nat. Pflanzenfam. Band 14 e (1940) 158; *Andropogon* spec. *auct.*

Perennial, rarely annual grasses with slender culms simple below, more or less branched above, the branches often gathered in fastigiate bundles, each supported by a bladeless sheath and terminated by a solitary raceme. Spikelets small, binate, one sessile, the other pedicelled, similar in shape, different in sex, on the fragile rachis of many jointed solitary spatheate racemes which are frequently gathered in fastigiate bundles, rarely the lowermost 1-3 pairs homogamous, joints and pedicels filiform, compressed, solid or slightly grooved, disarticulating horizontally; spikelets deciduous, the sessile with the adjacent joint and pedicel. Florets 2 in the fertile spikelets, the lower reduced to an empty glume, the upper hermaphrodite, I (the lower) in the pedicelled spikelets male or neuter, the other suppressed, or both suppressed. Sessile spikelet dorsally compressed, awned; callus small, shortly bearded; gl. I thinly chartaceous to membranous 2-keeled, with narrow inflexed margins; gl. II similar in texture, boat-shaped 3-nerved, acutely keeled; gl. III hyaline, nerveless; gl. IV reduced to a hyaline upwards firmer linear stipe passing into a slender awn.

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Stamens 3. Stigmas exserted laterally near the middle of the spikelet, longer than the styles. Pedicelled spikelets awnless; gl. III if present, hyaline, nerveless.

Type species: *E. foveolatus* (Del.) Stapf (*Andropogon foveolatus* Delile).

The members of this genus are distributed in the tropical and warm temperate regions of the old world and are good fodder.

The number of species attributed to this genus is disputed. We believe, however, that so far only three species can be included in this genus as it is understood today.

Andropogon foveolatus was described by Delile (4) in 1812. Roxburgh (5) described *A. strictus* in 1820. In 1889 Hackel reduced Roxburgh's species to a variety of *A. foveolatus*. In 1896 Hooker did not distinguish Roxburgh's species from *A. foveolatus*. An examination of the material and the descriptions reveal that these two species, viz. *A. foveolatus* Delile and *A. strictus* Roxb. differ as follows:

A. foveolatus Del. Slender, tufted, almost unbranched, culms upto 50 cm. tall. Sessile spikelet about 4 mm. long, pitted. Pedicelled spikelet usually not pitted. Glume II of pedicelled spikelet oblanceolate, flat on back, margins broadly and sharply inflexed.

A. strictus Roxb. Culms much branched, taller, sessile spikelet about 3 mm. long, pitted. Pedicelled spikelet also pitted. Glume II of pedicelled spikelet narrowly lanceolate, more or less rounded on back, margins narrowly incurved.

Roxburgh's species has been differently treated by various authors. The following discussion is an attempt to define its status.

As pointed out above, Hackel regarded *A. strictus* Roxb. to be a variety of *A. foveolatus* Del., and Hooker merged Roxburgh's species in Delile's.

Stapf, while describing *E. foveolatus* (*Andropogon foveolatus* Del.), mentions a pit in the sessile spikelet, but there is no mention of such a character in case of pedicelled spikelet. If Stapf had the same conception of this species as Hooker, he should have described the pedicelled spikelet as 'pitted or not', as Hooker did. Further there is no mention of *A. strictus* Roxb. in the synonymy, and this indicates that Stapf confined his *E. foveolatus* only to *A. foveolatus* Del. He, however, refers to Hooker in citations, suggesting that he paralleled his description with that of Hooker. Stapf also cites Hackel who regarded *A. strictus* Roxb. as a variety of *A. foveolatus* Del. Stapf does not clarify whether he included or not Hackel's var. *strictus*.

Camus (7) regarded *A. strictus* Roxb. as a separate species and named it *Eremopogon strictus* (Roxb.) Camus. Pilger also recognized it as a distinct species.

Hackel has referred to Stock's collection from Sind as the only record of *A. foveolatus* Del. from India. We have in the Dehra Dun Herbarium a sheet of Stock's from Sind. On requisition from the Blatter Herbarium, Bombay, we were supplied with three sheets under the name *A. foveolatus* Del. one of these specimens (Sabnis No. B. 615) is from Sehwanklaki, Sind. It resembles Stock's specimen from

Sind. Further, a specimen from Mauritius also resembles the specimens of Stock and Sabnis from Sind. These are true *Andropogon foveolatus* Delile. Other material collected from various parts of India agrees with the description of *A. strictus* Roxb., but since Hooker's time Roxburgh's species was not regarded as distinct from *A. foveolatus* Del. This whole material has been kept under *A. foveolatus* Del. It is, however, interesting to note that some of the older collections do bear the name *A. strictus* Roxb. These annotations were later on changed, apparently in the light of Hooker's view, to *A. foveolatus* Del.

The distribution of *A. foveolatus* Del. as mentioned by Hackel, Stapf and Pilger, suggests that this is a grass of arid and warm regions, viz. Africa, Mauritius, Egypt and Arabia and coming from south-west this species could establish itself in India only upto Sind. We may, however, expect to find this grass in Rajasthan (Rajputana), an area so far incompletely explored botanically.

We are inclined to regard *A. strictus* Roxb. as distinct from *A. foveolatus* Delile. The former species is now called *Eremopogon strictus* (Roxb.) Camus, and is the commonest species of this genus in India.

Andropogon foveolatus Del. is now *E. foveolatus* (Del.) Stapf. In 1924 Haines (8) transferred Delile's species to the genus *Hypogynium* Nees, and named it *H. foveolatus* (Delile) Haines. The genera *Hypogynium* and *Eremopogon* differ markedly in the sex character of the sessile spikelet (as pointed out above), and the combination made by Haines is incorrect.

Hackel described the species *A. tuberculatus* Hack. from peninsular India—'Asirgarh'. This grass has been collected only from Madhya Pradesh and now bears the name *Eremopogon tuberculatus* (Hack.) Camus (9).

Another species that Hackel described under his section *Eremopogon* was *A. delavyi* Hack. from China and Yunan. Camus (9) transferred it to *Eremopogon* and gave the name *E. delavayi* (Hack.) Camus. Hackel described glume IV of sessile spikelet as 'IV *ad aristae insertionem denticulis 2 hyalinis acuta*' (the awn inserted in the sinus of two hyaline teeth of glume IV). As is evident from the description of *Eremopogon*, this genus is characterized by the glume IV of sessile spikelet being stipitate, passing into an awn, and not at all bifid or bilobed, the latter being the characters of the genus *Schizachyrium* Nees. *Andropogon delavayi* Hack. was first collected by Bor from Assam in 1935. He transferred the species to *Schizachyrium* and named it *S. delavayi* (Hack.) Bor (10).

In 1911, Bhide (11) described a species, *Andropogon paranjpyeanum* Bhide, from Western Ghats (Bombay). Blatter and McCann (12) transferred this species to *Eremopogon* and gave the name *E. paranjpyeanum* (Bhide) Blatter et McCann. Bhide describes glume IV of sessile spikelet as 'gl. IV the narrow base of the awn, just a little more than half as long as I, obscurely margined and 1-nerved, with two *obscure narrow lobes at the apex and an interposed slender twisted scabrid awn*'. The figure of gl. IV as illustrated by

Bhide also clearly shows two lobes at the apex of gl. IV. An examination of the type specimen of this grass further revealed that:

(i) The pedicelled spikelet is 5 mm. long, while the sessile is only about 3.5 mm. or less.

(ii) The gl. I of sessile spikelet is keeled upwards.

(iii) The joints and pedicels are slightly thickened and obliquely truncate above.

All these characters lead us to believe that Bhide's plant cannot be fitted into the genus *Eremopogon*. It very closely approaches the genus *Schizachyrium* Nees. We have proposed for Bhide's plant the name *Schizachyrium paranjpyeanum* (Bhide) Raizada et Jain (13).

Thus only three species can be attributed to the genus *Eremopogon*, all of which are found in India. *E. foveolatus* Stapf extends from Africa through South-west Asia to India, while *E. strictus* (Roxb.) Camus and *E. tuberculatus* (Hack.) Camus are apparently endemic in India.

KEY TO THE SPECIES OF *EREMOPOGON*

A. Gl. I of the sessile spikelet glabrous, smooth, pitted.
  x—Culms unbranched, slender. Sessile spikelet about 4 mm. long. Pedicelled spikelet usually not pitted, gl. II of pedicelled spikelet oblanceolate, with margins sharply inflexed and overlapping each other ... *E. foveolatus*
  y—Culms branched, taller. Sessile spikelet about 3 mm. long. Pedicelled spikelet pitted; gl. II of pedicelled spikelet narrowly lanceolate, margins narrowly incurved ... *E. strictus*
B. Glume I of sessile spikelet tuberculate at keels and nerves, not pitted ... *E. tuberculatus*

Eremopogon foveolatus (Del.) Stapf in Dyer's Fl. Trop. Africa IX (1917) 183; Pilger in Die Nat. Pflanzenfam. Band 14 e (1940) 158.

Andropogon foveolatus Delile, Fl. Egypte (1812) 160, t. 8, fig. 2; Hk. f. Fl. Br. Ind. VII (1896) 168 *partim*.

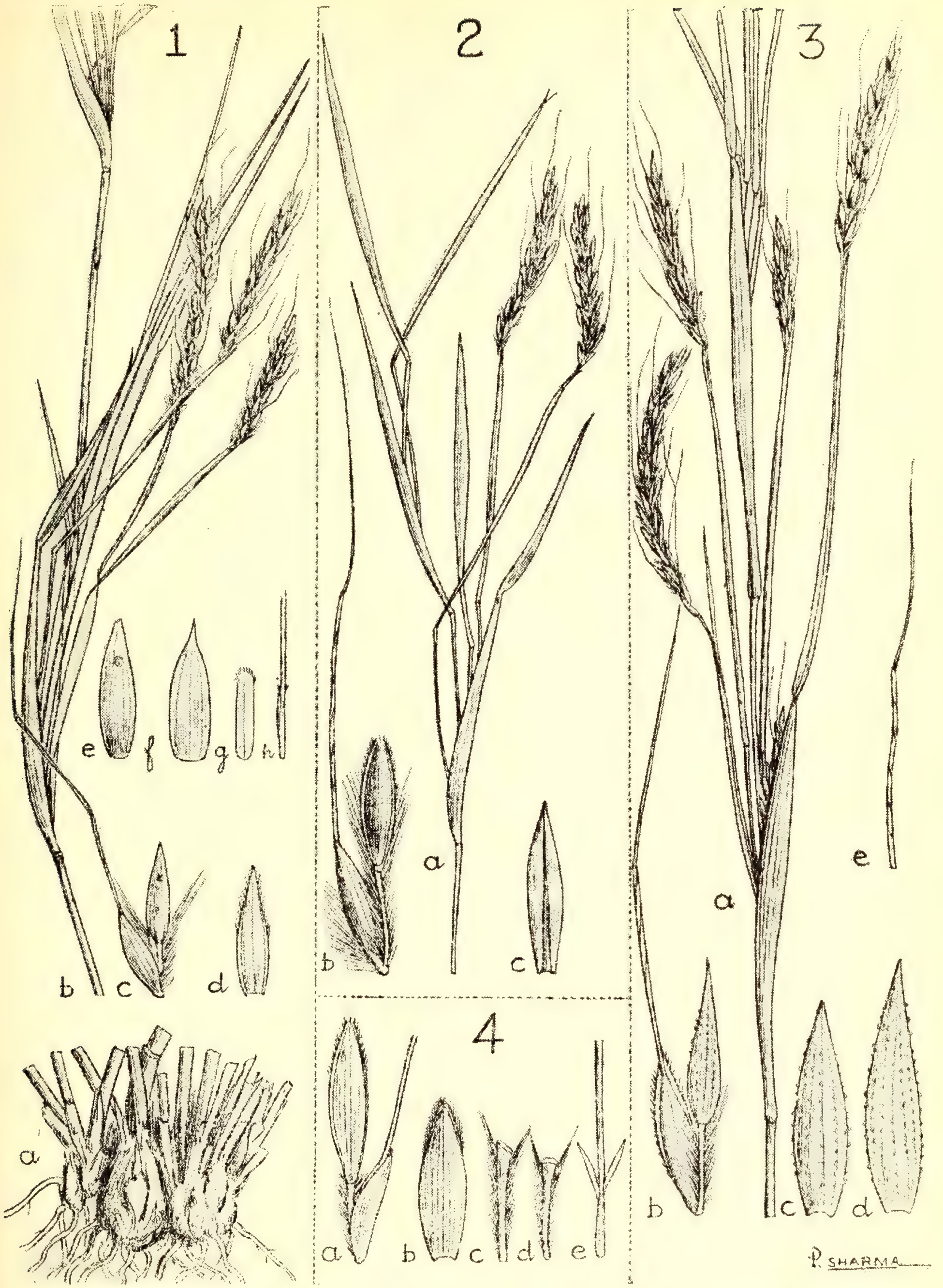
Perennial, densely tufted from short, branched rhizomes. Culms very slender 15–50 cm. tall, geniculate at base, rarely quite erect, about 3-noded and usually simple below the flowering branches, terete, glabrous below the bearded nodes, sometimes scaberulous or puberulous. Basal leafsheaths short, broad, whitish, thin, more or less silky, those of the culms terete, glabrous except at the nodes, pale green, slightly scaberulous; ligules hyaline, rounded, ciliolate, 1 mm. long, continued into the sheath margins; blades linear, acute, 2.5-7.5 cm. long and 1–2 mm. wide, tightly folded or at length more or less flat, glaucous, pruinose to minutely puberulous on both sides, margins cartilaginous, smooth or nearly so, generally with a few cilia near the base, mid-rib keeled below, primary lateral nerves 2 on each side. Flowering branches solitary or fascicled, slender, simple, sometimes flexuous, or geniculately ascending, more or less fastigiate; spathes very narrow, acute, 4-5 cm. long, scaberulous; peduncles filiform, at length exserted from the spathe, puberulous above, tips hardly thickened. Racemes slender, dense, 2.5-4 cm. long, erect or nodding, somewhat silky; joints and pedicels filiform, disarticulating obliquely with a short ovate transparent appendage about 1 mm. long, densely ciliate along the margins, the uppermost cilia upto 2 cm. long. Sessile spikelet lanceolate, including the short callus, the beard of which reaches more or less upto the middle of the spikelet, 4 mm. long, pale and shining with reddish tips. Glume I and II equal, subchartaceous to almost membranous, glabrous; gl. I minutely 2-toothed or sub-entire and minutely truncate, slightly concave on the back, inflexed margins narrow, forming scaberulous keels upwards, intracarinal nerves 2, with a circular pit between them above the middle; gl. II oblong, obtuse, semimucronulate, broadly rounded on the back, 3-nerved ciliolate; lower floret reduced to a linear-oblong hyaline very sparingly ciliolate nerveless glume, not more than 2 mm. long. Upper floret bisexual, gl. IV reduced to an awn, 12-20 mm. long, with a short white stipe, the remainder divided about equally into a slender brown column and a paler bristle, both scaberulous. Anthers less than 1 mm. long. Pedicelled spikelet as long as or slightly longer than the sessile, oblong, barren. Gl. I greenish tinged with red or more or less suffused with purple, 2-keeled all along, intracarinal nerves 3, the lateral close to the keels; gl. II oblanceolate, acute, sub-hyaline, 3-nerved, ciliolate, margins broadly and sharply inflexed, rather overlapping each other above; gl. III if present, hyaline, nerveless, 2 mm. long.

Distribution	...	Sind, Africa, Egypt, Arabia.
Ecology	...	A grass of arid warm regions.

Eremopogon strictus (Roxb.) Camus in Ann. Soc. Linn. Lyon. 68 (1921) 207; Pilger in Die Nat. Pflanzenfam. Band e (1940) 158. *Andropogon strictus* Roxb. Fl. Ind. 1 (1832) 261; Duthie Grasses NW. India (1883) 20, fodder Grasses N. India (1888) 34, t. 21; Lisboa Bom. Grasses (1896) 64. *Andropogon foveolatus* Hook. f. Fl. Br. Ind. VII (1896) 168 *partim*; Prain Beng. Pl. (1903) 1203; Cooke Fl. Bom. 2 (1908) 977; under *Eremopogon foveolatus* (Del.) Stapf in all Indian floras; *Hypogynium foveolatus* (Del.) Haines in Bot. Bihar and Orissa (124) 1041.

Perennial, culms 30-60 cm. or more long, much branched, densely tufted, usually decumbent at the base, then geniculately ascending, very slender, glabrous; nodes bearded. Leaves 7.5-15 cm. by 1.2-2.5 cm., linear, scaberulous beneath; sheaths shorter than the internodes, scabrous or glabrous, generally with few cilia near the base; midrib prominent, with 2 or more lateral nerves; the basal sheaths silky villous; ligul short, truncate, hyaline, ciliate.

Racemes 2.5-3.8 cm. long, solitary; peduncles capillary, erect, usually far exserted beyond the slender spathe; joints and pedicels



1. *Eremopogon strictus* Camus. a. Base of culm × 1. b. Upper part of plant × 1. c. A pair of spikelets × 5. d. Gl. II of pedicelled spikelet × 7. e.-h. Gl. I-IV of sessile spikelet × 7.

2. *E. foveolatus* Stapf. a. Upper part of culm × 1. b. A pair of spikelets × 5. c. Gl. II of pedicelled spikelet × 7.

3. *E. tuberculatus* Camus. a. Upper part of culm × 1. b. A pair of spikelets × 5. c. Gl. 1 of sessile spikelet × 7. d. Gl. I of pedicelled spikelet × 7. e. Gl. IV of sessile spikelet with awn × 3.

4. *Schizachyrium paranjpyeanum* Raizada et Jain. a. A pair of spikelets. b. Gl. I of sessile spikelet × 7. c. Joint × 7. d. Pedicel × 7. e. Gl. IV of sessile spikelet with awn × 7.

slender, ciliate on two opposite sides, with long silky hairs, shorter than the sessile spikelets. Spkts. 3 mm. long (the sess. and ped. equal), oblong-lanceolate, glabrous, purplish, callus small, shortly hairy at the base; gl. I 3 mm. long, flat, lanceolate-oblong, subobtuse, with narrowly involute margins. 4-nerved, usually marked with a deep pit above the middle; gl. II equal, lanceolate, acute, obscurely 3-nerved; gl. III much shorter, oblong-lanceolate, glabrous, nerveless; gl. IV reduced to base of an awn, awn 13-16 mm. long, the column nearly equal to the subulate portion. Anthers 2.5 mm. long. Pedicellate spikelets:—Pedicels 2.5 mm. long. Gl. I more or less 3 mm. long, lanceolate, acute, with incurved margins, the keels above acutely scabrid. 5-nerved, pitted gl. II equal, linear-lanceolate, acute, 3-nerved, with narrowly incurved margins.

Distribution	...	Widely distributed in India.
Ecology	...	This grass occurs in varied localities, dry open places, ravines and low hills. It is a good fodder.

Eremopogon tuberculatus (Hack.) Camus in Ann. Soc. Linn. Lyon. 68 (1921) 207; Pilger in Die Nat. Pflanzenfam. Band 14 e (1940) 158. *Andropogon tuberculatus* Hack. Monog. Androp. VI (1889) 404; Hk. f. Fl. Br. Ind. VII (1896) 168.

Perennial; culms 1.5 m. tall, robust, many noded, round, glabrous, striated, paniculately branched. Sheaths glabrous smooth; nodes glabrous. Ligule ovate-oblong, acute, 4-6 mm. long, hyaline, laterally decurrent into sheath. Leafblade 40 cm. long, 0.4-0.6 cm. broad, linear, rigid, glaucous, glabrous, tightly infolded, at length flat, setaceously acuminate, base narrow, margins scrabrous; midrib thickened at base, here occupying almost entire breadth of the lamina, lateral nerves very closely set. Panicle leafy, spatheate, 20-35 cm. long, branches 3-5, filiform, erect, subfastigiate, primary often branched, the rest simple. Spathe very narrow, scabrid, with tubercle based hairs. Peduncles 5-10 cm. long, strict, scabrid. Racemes 2.5-3.5 cm. long, erect, pale green or suffused with purple. Joints and pedicels linear, stouter than in other species shorter than the sessile spikelet, ciliate with white hairs, which are longer at apex. Sessile spikelet 5 mm. long, linear-lanceolate. Callus small, sparsely and shortly hairy. Glume I chartaceous-membranous, more or less acute or narrowly truncate, entire, margins narrowly inflexed, dorsally flat or ridged, rough, glabrous, 3-7-nerved, nerves tuberculate, faint near the apex. Gl. II equal to I, membranous, lanceolate, acute, 1-nerved, keel tuberculate, margins narrowly inflexed, ciliolate. Gl. III same size, linear, lanceolate, acute, nerveless, margins incurved, glabrous. Gl. IV slender base of an awn 16-18 mm. long, column erect shorter than subula. Lodicules cuneate, cuspidate. Stamens 2, anthers 2 mm. long. Pedicelled spikelets male, blunt. Gl. I prominently nerved. Gl. III ciliate. Gl. IV absent; anthers large, 3.5 mm. long, rest similar to sessile spikelet.

Distribution	...	Madhya Pradesh.
Ecology	...	A handsome, mildly scented (Duthie) grass, occurring near water.

AFFINITIES OF THE GENUS *EREMOPOGON* STAPF WITH *SCHIZACHYRIUM* NEES

Owing to lack of material at our disposal we have been unable to make a comprehensive study of the genus *Schizachyrium* vis-à-vis *Eremopogon*, but from what we have examined and discussed below, it would appear that the genera *Schizachyrium* and *Eremopogon* are very close.

Stapf has kept his genus *Eremopogon* in the subtribe *Amphilophiastrae* and he distinguishes the latter from the subtribe *Schizachyriastrae* as follows:

	AMPHILOPHIASTRAE	SCHIZACHYRIASTRAE
(i)	Awn forming a continuation of the stipiform fertile valve.	Awn from the sinus of the 2-fid or 2 dentate fertile valve.
(ii)	Joints and pedicels slender, filiform with a translucent middle line, tips unappendaged.	Joints and pedicels often somewhat stout, thickened upwards, with more or less appendaged tips.

Other authors such as Bews, Blatter, Fischer, Mooney and Pilger also separate *Eremopogon* from *Schizachyrium* on the basis of glume IV and the joints and pedicels. These two characters have been discussed below one by one.

(i) *Glume IV of sessile spikelet (referred as glume below)*:

A number of specimens of *Eremopogon strictus* (Roxb.) Camus from various parts of India were examined. Many of them showed bidentate or shortly bifid apex of the glume. It was these instances which first drew our attention to this subject. At one time we even considered separating these specimens with bidentate glume and transferring them to *Schizachyrium*, but their slender joints and pedicels necessitated further study of the material. Soon we came across specimens having wholly entire and shortly bidentate glumes in one and the same inflorescence. This further prompted us to scrutinize the material and descriptions of *Eremopogon* and *Schizachyrium*.

It was interesting to note that in the description of the genus *Schizachyrium* Nees, Stapf has mentioned 'Fertile valve (gl. IV) usually 2-fid, sometimes very deeply, or 2-dentate, rarely *entire*, awned from the sinus or *continuing* the entire valve.'

A scrutiny of Stapf's descriptions of the various species of *Schizachyrium* revealed that actually there are all stages of division of the glume; on the one hand there are species with entire glume and on the other the glume is divided deep, almost to the base, and there exist all intermediate stages.

(ii) *Joints and pedicels*:—

An examination of the joints and the pedicels from the specimens and the descriptions of *Eremopogon* and *Schizachyrium* also revealed a gradual variation in their thickness.

In this respect the most significant anomaly is to be noted in the descriptions of the genus *Eremopogon* and its type species *E. foveolatus* Stapf. Stapf, while describing the genus *Eremopogon*, writes—'Joints and pedicels filiform compressed, solid or slightly grooved, *disarticulating horizontally* !' In the description of the type species *E. foveolatus* Stapf writes—'Joints and pedicels filiform, *disarticulating obliquely*, with a short ovate transparent appendage about 1 mm. long. The oblique articulation and presence of an appendage in the joints and pedicels, are the characters of *Schizachyrium*'.

On the other hand some species of the genus *Schizachyrium* have very slender, rather filiform, less or un-thickened joints and pedicels; sometimes even their appendage is absent.

It would appear from the above discussion that the characters by which the genus *Eremopogon* has been separated from *Schizachyrium* are of very little practical value. A study of the generic descriptions and the material also does not suggest any other characters which might be regarded as constant and distinct enough to be of taxonomic value. The absence of clear demarcation between these two genera is also indicated by the two instances discussed earlier in this paper, viz. of *Andropogon delavayi* Hack. (*Eremopogon delavayi* Camus, *Schizachyrium delavayi* Bor) and *A. paranjpyeanum* Bhide (*E. paranjpyenum* Blatter et McCann, *S. paranjpyeanum* Raizada et Jain).

We are inclined to believe that further study will confirm the view that by slightly emending the characters of the genus *Schizachyrium* Nees, *Eremopogon* Stapf can be merged into the former.

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INFLUENCE OF STAGE OF TIDE ON THE ATTACHMENT OF BARNACLE CYPRIDS[1]

BY

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(*With three graphs*)

Introduction

Conflicting views have been held regarding the effect of the stage of tide on the settlement of barnacle cyprids. While Weiss (1947) found that the highest rate of attachment of cyprids of *B. improvisus* occurred during the low tide period, Vischer and Luce (1928) found that an increasing tide favoured settlement of cyprids of *B. improvisus* and *B. amphitrite*. The latter view was accepted by McDougall (1943) in explaining the different distributions of the barnacle *B. eburneus*. Cyprids of *B. crenatus* were found by Pyefinch (1948) to become more abundant later in the tide, i.e. as the ebb falls away to slack water. Nevertheless, Barnes (1950) is of the opinion that the dominance of the cyprid larvae later in the tide, at Millport, is doubtful.

Since it would appear that different species react differently, the rate of attachment in relation to stage of tide was studied with reference to cyprids of three species *Balanus amphitrite variegatus, B. tintinnabulum tintinnabulum*, and *Chthamalus stellatus stellatus* which are the common barnacles occurring abundantly in Madras.

Methods

The attachment of larvae was studied by exposing test panels, which measured 16″ × 20″ and had become previously coated with the primary algal film shown to be essential for the attachment of the barnacles (Daniel, 1955 *b*) from high tide level to low tide level for two-hour periods. The panels were suspended vertically by a pair of stout galvanized copper wires. An iron weight attached at the lower end of the plank ensured the vertical position. At the top the wires were attached to a projecting iron rod. At the end of the two-hour period the numbers of cyprids settled were counted.

Experiments for *Balanus amphitrite* were conducted in the new north quay of the Madras harbour, where only this species of barnacle settled in appreciable numbers.

Experiments for *Balanus tintinnabulum* were conducted on the seaward side of the concrete break-water to the north of the harbour, on the Rayapuram shore, where only *B. tintinnabulum* settled abundantly.

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[1] Part of a thesis approved for the Ph.D. degree of Madras University

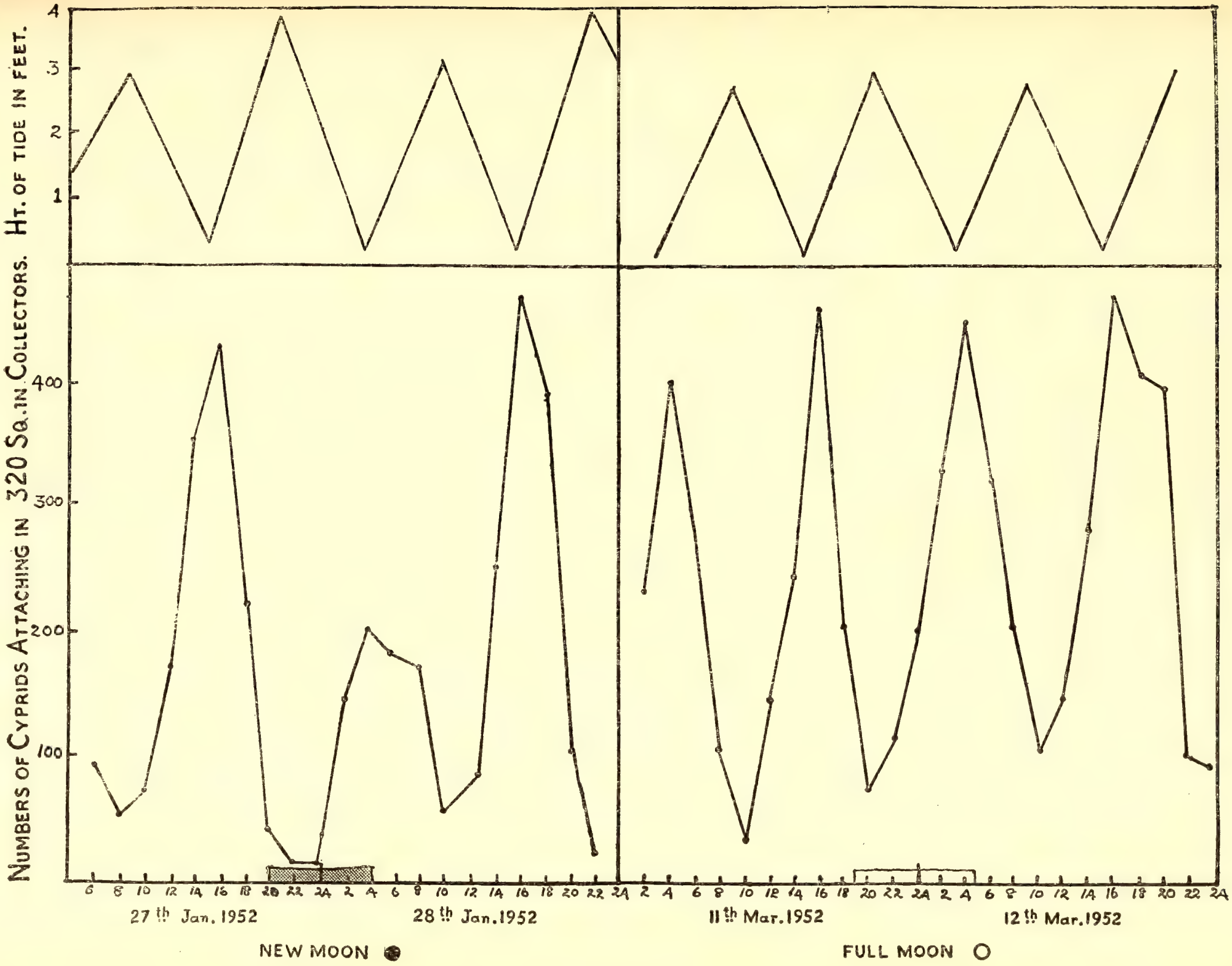

FIGURE 1

Showing the relation between the attachment of cyprids of *B. a. variegatus* to tide and phases of the moon.

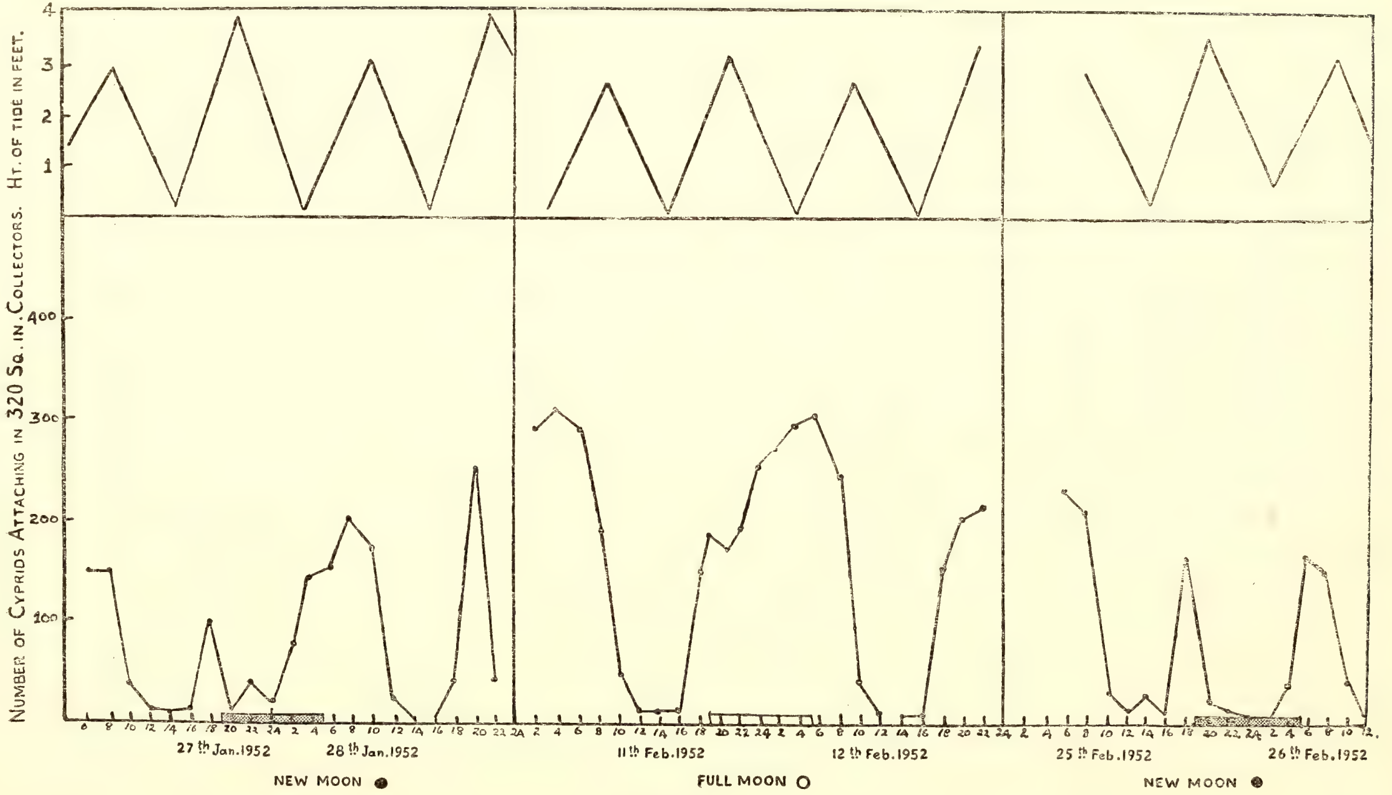

FIGURE 2

Showing the relation between the attachment of cyprids of *B. t. tintinnabulum* to tide and phases of the moon.

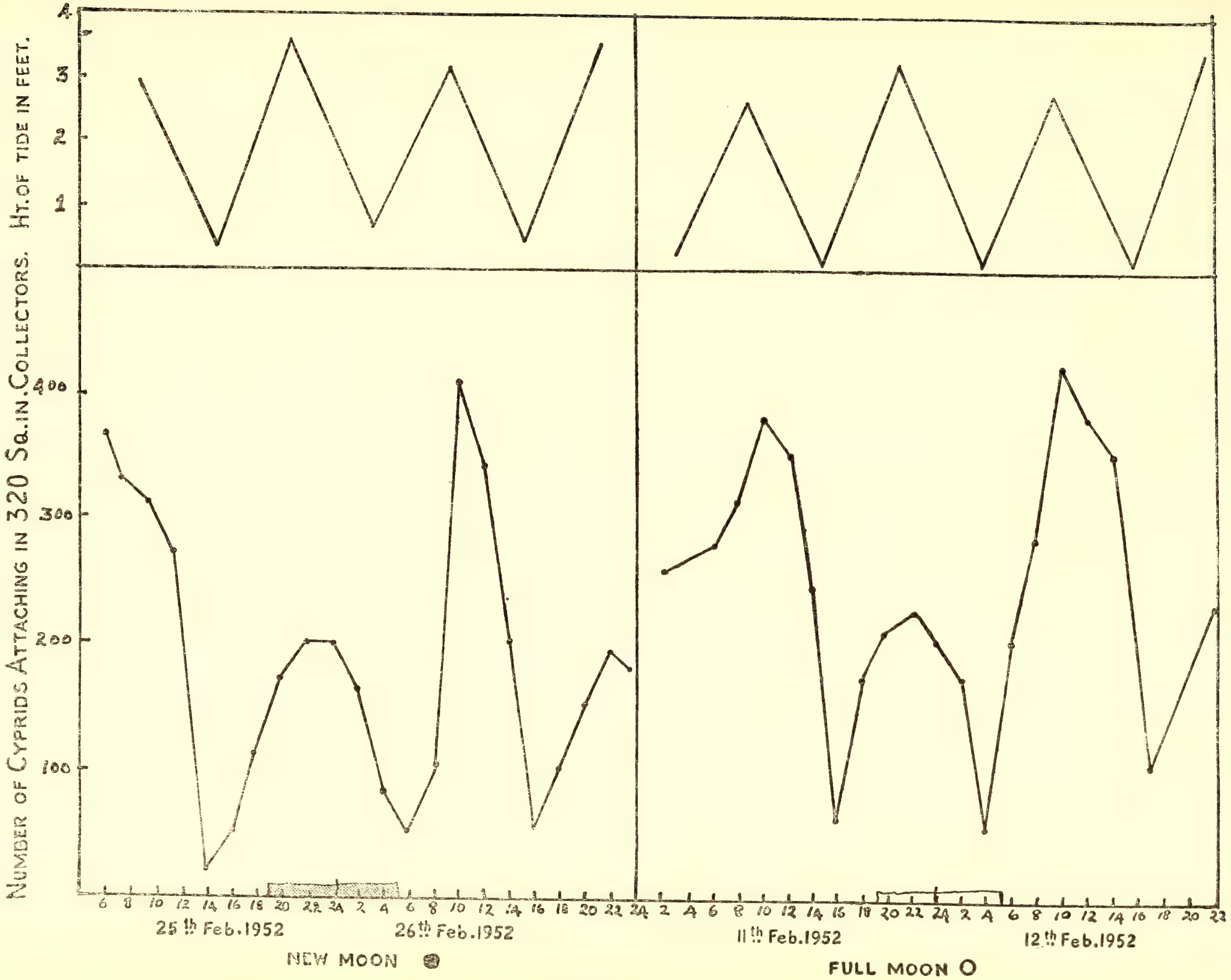

Figure 3

Showing the relation between the attachment of cyprids of *C. s. stellatus* to tide and phases of the moon

Experiments for *C. stellatus* were conducted on the shore between Rayapuram and Tondiarpet, where only *C. stellatus* occurred abundantly. Details of the distribution and settlement of these barnacles and of the distinguishing characters of the cyprids have been given elsewhere (Daniel, 1954, 1955 *a* and 1957 *b*). This study covered the new moon and full moon days.

RESULTS

The data for these three different species, *Balanus amphitrite*, *B. tintinnabulum* and *C. stellatus* during January, February and March 1952 are presented in figures 1, 2 and 3 respectively.

A perusal of Figure 1 will show that, in general, maximum attachment of *B. amphitrite* occurred during low tide. It is obvious from Figure 2 (the attachment of *B. tintinnabulum*) that this species, unlike *B. amphitrite* and *C. stellatus*, is not influenced so much by the tides as by illumination. It is probable that what little effect the stage of the tide may have on settlement, is masked by the influence of illumination due to sunlight during the periods of low or high tide. From Figure 3 it can be seen that *C. stellatus* preferred to settle at high tide than at low tide.

REMARKS

Evidently these species of barnacles respond differently to the different stages of tide. These differences in behaviour must now be considered in relation to the three distinct habitats to which the species are confined. *Chthamalus stellatus* being a form inhabiting the supralittoral fringe of rocky coasts, the cyprids can reach the rocks on the shore only at high tide while the ebb tide can carry the larvae of *B. amphitrite* (occurring abundantly about one foot below the surface of low tide) to the deeper waters which they inhabit. Such of the cyprids of *B. amphitrite* as are carried shorewards during the high tide and have managed to settle, probably perish by the violence of the waves or during the explosure in the succeeding ebb period. In the same way cyprids of *C. stellatus* carried away to deeper waters by ebb tide would never find suitable substrata at levels where maximum illumination and oxygen could be obtained. They could, however, survive and be carried shoreward during the next high tide. The response of cyprids of *B. tintinnabulum* which abounds in the sublittoral fringe of rocky coasts ten feet below mean sea level, is so closely bound with the reaction to illumination (Daniel 1957 *a*) that it is probable that during high tide the cyprids brought close to the shore are prevented from attachment not only by the violence of the waves but also by the intensity of the sunlight, and those drawn back into the deeper waters by the ebb and flow do not get substrata at depths which secure the required illumination. It is therefore probable that the cyprids of this species go shorewards and seawards during the two different tides till they settle on substratum at intermediate depths between those preferred by *C. stellatus* and *B. amphitrite*. Therefore, the reaction of the three different species must be related to the nature of the habitat rather than to any inherent response to tidal rhythm.

SUMMARY

Cyprids of *B. amphitrite* settle in large numbers during low tide, whereas cyprids of *C. stellatus* prefer to settle at high tide, and cyprids of *B. tintinnabulum* appear indifferent to the stage of tide.

It is suggested that the reaction of the cyprids of the three different species must be related to the nature of their habitat rather than to any inherent response to tidal rhythm.

ACKNOWLEDGEMENTS

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REPTILIANA

BY

LIEUT.-COL. A. H. E. MOSSE[1]

Reptiles! The mere intonation with which, quite instinctively, one gives utterance to the word, makes cause for wonder whether there is any good to be said of them. Yet, when dealing just now with the little Gecko indoors as a member of one's household, one had almost forgotten that he is one of the tribe. The most conspicuous of the harmless garden lizards that scurry across one's path is the so-called 'bloodsucker' (*Calotes*), who puffs out his throat at you in the endeavour to look important, but only succeeds in being ridiculous. In the effort his whole throat becomes suffused with crimson, a change of colour which is presumably responsible for his being sometimes called a chameleon, which he certainly is not.

The true Chameleon is a lizard of more pre-historic mould, which I have personally come across in India only in the Nilgiri Hills, but have also met in southern Arabia. An amazing creature I found him. His colour transformation schemes were, it seemed, dependent in part upon the hues of his environment and background, and in part upon the nature of the light falling on him. They varied from brilliant green with black spots and blotches, to orange-brown or a dirty cream marked with brown. But, apart from changes in his uniform, it was his eyes and the character of his movements which gave one the impression that here was an entirely unique personality.

A squint-eyed regard can make one feel uncomfortable, you never know whether the eye concerned is looking at you or not. But the effect is still more disconcerting when a creature, in the act of contemplating a blue-bottle fly; deliberately swivels round one of the ball-and-socket arrangements—the epithet is EHA's—which serve it for eyes, in order to study you, while the other continues without interruption the more important business of estimating the range of that insect. The thing purports to be a lizard, but you cannot believe it to be real, and feel sure there must be an invisible someone pulling a string to work the machine.

Having decided that you are not a person of any account, the right eye returns to the assistance of its colleague; and the owner of both, after some further consideration, concludes—unless the blue-bottle has in the meantime become bored and moved on—that the range is excessive and must be reduced. To that end he uncoils his tail, which has been wound round a supporting twig or other perch, leisurely unclasps the grip of the fingers of one fore-paw, and as leisurely moves it forward to take up a fresh grip. Then, at the pulling of that invisible string again, the other hand does likewise; after which a short rest is necessary before the right hind foot begins to take its share in the advance. And so on.

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[1] This is a further chapter from the late Col. Mosse's MS. The first appeared in Vol. 54 (3).

It is slow motion *in excelsis*. When the Whiting was impelled to invite the Snail to walk a little faster, I expect the latter was doing his little best. The snail is slow, not a doubt of it; yet he does not move with the studied deliberation of the chameleon. The panther stalking a wary prey can, by virtue of sheer concentration, move his paw at a rate of fractions of an inch per second; but you know that same paw can strike like the lightning itself. The chameleon, however, cannot be imagined progressing any faster than he does. Not because you think he cannot do so, but just because he does not choose; while any attempt to hustle him would, you feel, be an unwarrantable interference with one of the fixed laws of dynamics.

When at length he has arrived within range—perhaps six inches—of his quarry, the chameleon tightens his grip with hands and tail, parts his lips, and the next moment the blue-bottle has disappeared within those cavernous jaws with a leap that the eye is unable to follow. It is just as fast as that; after the portentous slowness of every previous movement it leaves one gasping. One cannot help wondering whether the real explanation of the reptile's superlative leisureliness of limb is not to be found in the necessity of concentrating all the speed of which his being is capable into the manipulation of the lasso which is his tongue. For, in effect, it is like a lasso that he wields his weapon, with the difference that instead of a noose he employs a blob of liquid glue on the tip of his tongue. I have taken longer than I had intended over a description of the chameleon's methods; but what is one to do when dealing with a creature to whom time is of no account?

In Gujarat I never met a chameleon[1]. A reptile, however, that is frequently in evidence there, especially if you keep fowls, is that big lizard of antediluvian appearance usually miscalled the Iguana, in reality a Monitor. I once had a neighbour who was a poultry fancier and found his prize White Leghorn chickens disappearing in mysterious fashion. He set traps for the mongoose which he believed to be the culprit, but without success. One afternoon he and I were in the compound when we saw something scuttle away from the vicinity of a wired-in fowl run, then sit up on its haunches and look round to inspect us—exactly as a mongoose will do when he cannot quite make out what you are. 'I knew it was a mongoose', said my friend. But it was not. The next moment it was down on all fours and its gait as it waddled off gave it away—a monitor or *ghorpad*, what the Gujarati calls a *gho*. This particular specimen escaped for that time, but was shot a day or two later, a big fellow nearly four feet in length. In its interior were found the remains of a couple of chickens and of a young partridge, as well as eggs of some small bird.

The *gho* is a voracious poacher; but the evil reputation in another respect which he bears among the natives is undeserved. I once picked up a young one by the tail in the presence of a *patawala*—the office menial whom they call a *chuprassi* further north—and it turned and seized my finger in its teeth. I have never seen a brown skin turn such an extraordinary colour; the man was livid with genuine horror, fully expecting to see me drop dead For the *ghorpad*, when young and spotted—it loses its spots as it grows up—is credited with a bite more deadly than the cobra's; a complete delusion, for India possesses no poisonous lizard known to science.

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[1] Although it does occur and is even locally common there. EDS.

What the creature does own is a set of powerful claws with which it can maintain a most tenacious grip. It is said that in olden days burglars used to employ the *ghorpad* to help them to climb up walls and into houses, sending the creature on ahead with a light rope fastened around its waist. And tradition has it that the Marathas once utilised the services of a large *ghorpad*, in just this fashion, to provide them with the means of scaling the impregnable and therefore unwatched side of the ancient fort of Singarh, and thus to capture it from the Moghals. Life is not too easy for the *ghorpad*. Poisonous or not, the Waghris and other unfastidious folk have always eaten him with gusto, while in these days his skin makes ladies' hand-bags.

In the case of that still bigger lizard, the Mugger (Crocodile), it is suit-cases and so forth. Which is just as well, for, unprepossessing anachronism that he is, I do not know what else he is good for in the modern world. Like every lizard, large or small, his one interest in life is food. Other animals will regard you with frank curiosity, or as frank suspicion. But the eyes in that horny head, the top of which, as it floats slowly past you standing on the bank, is all that is visible above the surface of the water, are solely concerned to appraise your possibilities as meat. So at least I always fancy. The particular mugger we are observing is probably not big enough—few are in these parts—to tackle an adult human being if it had the chance. None the less I do not believe it constitutionally capable of considering a living creature from any other point of view.

Look into the chill expressionlessness of the crocodile's lidless grey-green orbs. I have spoken elsewhere of the cruelty in the eyes of a jungle-cat, of the sinister character of the wolf; but these are warm-blooded animals, and their eyes capable of varying expressions in tune with varying moods. In the eye of the crocodile is a quality of changelessness that chills one with an impression, such as no mammal's eye ever gives forth, of unmixed evil. Catch a wolf young enough and you may tame him. One cannot conceive of any response from a mugger.

One of the tribe once gave me a shock, though that is not why I abuse them. This particular individual was the sole inhabitant of a tank, the greater part of which had dried up in a year when the rains had failed. In the alluvial soil of the tank bed, adjacent to the water that remained, an enterprising ryot had sown a winter crop of wheat. One afternoon it was reported to me that the mugger was on land having a siesta. I was at the time in want of material for the making of a crocodile-skin attaché case, and here it was to hand. I sallied forth with my rifle.

As a rule a basking mugger lies within a very few feet of the water's edge, sometimes half in the water. I was therefore surprised to find, in this instance, that my prospective quarry was lying in the young wheat, then some eight or nine inches high, at a distance of fully twenty yards from the water. The less chance of his escaping, thought I, as I took aim from behind the bund at perhaps seventy yards' range.

I fired. There was not a move. I have found that a bullet accurately placed in the back of the neck will kill a mugger stone dead, though some spasmodic movements will normally follow. In this case there was not even a quiver, which was surprising. But it has been my experience that, at the sound of a shot, every mugger on shore within half a mile will plunge straightway into the water. There seemed no reason to doubt that the beast was dead. Leisurely I reloaded and made my way across the bed of the tank towards him.

I was within six feet of the dead croc, when it suddenly came to life and swung round upon me, with jaws in a flash flung open wide, and a loud intimidating hiss, to the horror of my wife and small daughter watching the affair from the opposite bund! To my own horror no less. I had indeed, as may be imagined, one of the shocks of my life, only comparable to that given me years before by a wounded panther when I all but trod upon him. However, recovering myself, I made sure this time with two rapid shots.

Then came the final surprise, when examination of the now really defunct beast could find no trace whatever of the original bullet. My first shot must have been just too high and missed him clean! It was an extraordinary affair, of which there seem two possible explanations. One that the crocodile was deaf, had not heard the first report or the whizz of the bullet over him, and was unconscious of my approach in silent rubber soles until I was almost upon him. The other, that it had the intelligence to realise that, while in a measure concealed by the wheat in which it lay, a move to cover the unusual distance between itself and the water might be only exposing itself to danger. This possibility seemed strengthened by the fact that there was a malformation of one of the animal's hind feet which doubtless would have slowed down an attempt to escape. Which fact again, as also the fact of deafness if it existed, made all the more surprising the exceptional distance from the water. Whether he was really lying 'doggo', or merely deaf, must remain undecided. Between seven and eight feet long, this was not a large mugger, but quite large enough to have given me ample cause to regret our encounter, had I been a pace nearer when he moved!

My surprise at this crocodile choosing to bask in the open in daylight so far as twenty yards from his native element is not affected by the well-known fact that these animals will travel long distances by night from one river or piece of water to another. I once found a pair of small ones, each between two and three feet only in length, in a village well. The villagers stated that they had been discovered in the well one morning a week before, having obviously arrived the previous night and, attracted by the water in the well, had fallen in. In this case the nearest water where muggers were known to exist was about five miles away.

But enough of these foul relics of a vanished age.

And so to the snakes. Nobody loves snakes. The same, it is true, may be said of the mugger; but comparatively few folk ever meet the latter, while snakes, though to a less degree than sometimes supposed, are liable to enter into the life of any one. And many of them are not only entirely harmless but often do good work in the destruction of rats and such-like vermin. Moreover, prejudice apart, some of them have their attractive points. Squirmy things, no doubt, but does one ever see a snake that is not sleek and clean, with a well-groomed look about him, in fact? Except, of course, at the uncomfortable, dishevelled time of sloughing his skin.

That does not alter the fact that the snake is anathema to mankind in general; this for a combination of reasons. Its writhing mode of progression, for one thing, tends to have a discomfiting effect upon the human observer. And man can never quite forget, either the traditional association of the serpent form with the Evil One, or the possession by some of the race of an instrument of death, the deadliness of which seems out of all proportion to the importance of its possessor. Well do I remember the horror of my first intimate contact with—but the tale will not take long in the telling.

It was my first year in India. A young subaltern dressing for dinner, I pulled on a mess wellington boot to feel something alive under my heel—Heaven! a snake! With a presence of mind on which that sudden deathly cold feeling up my spine did not prevent my priding myself, I rammed my heel down and stood upon it hard! After a couple of minutes, when surely it must be safe, I got my bearer to pull off the boot, to find in the heel the loathly remains of what had been—a miserable toad! Can you wonder that, between the sight of the beastly mess and sudden revulsion of feeling, I was immediately deadly sick? But that did not do the unfortunate toad any good.

Since that memorable night I have neither seen nor experienced any hairbreadth escapes; when one considers it, indeed, it is rather remarkable how comparatively few of these reptiles one sees. Snakes one has encountered of course, and naturally calls to mind first the most notorious kinds: Cobra, Daboia or Russell's Viper and Krait, the *Echis* Viper or Phoorsa a trifle less deadly. It was a daboia, coiled up in the middle of the track, whose unexpected appearance as we turned a corner made my pony shy; then turned out to be dead, without mark of injury. I shall have more to say of the daboia presently.

It was a cobra, of the black variety with neither spectacles nor monocle upon his hood, which demonstrated the promptness with which he could seize an opportunity, in the form of a painted partridge fallen to my gun within a yard of where he lay basking in the sunshine; you would have supposed it too big a mouthful for him to put away, but he obviously did not think so. He was not allowed to try.

It was another large black cobra which once afforded a Muslim Mounted Police orderly of mine a chance of displaying his prowess with the sword. We were riding along a sort of lane with a bank on one side, when a cobra that had been coiled up on the bank, roused by the sound of the passing hoofs, reared itself up with hood expanded after the fashion of its kind, its head about saddle high as we rode below. Maula Baksh was an ex-sowar of a famous cavalry regiment, and an expert performer at 'heads and posts'. At the sight of this heaven-sent opportunity his eyes gleamed, as he begged eagerly to be allowed to practise his favourite exercise on the person of a living foe. Back he cantered some sixty paces, then, as all unwitting of its imminent danger the cobra held its ground, down upon his enemy swept the old soldier in whirlwind charge. Above the horse's ears, and perfectly timed, came the swishing back-hand stroke of a blade in whose keenness its owner had always taken pride, and that swaying menacing head was removed as cleanly as had been each coconut at the last competition which Maula Baksh had won.

It was the phoorsa, of which I read, and did not question the statement, that while a superficial resemblance may cause the Brown Tree-snake to be mistaken for it, this viper is no climber and is never seen off the ground. Authorities are not always infallible, so it may not have been merely ophidian cussedness which led to my finding the phoorsa, on the next half dozen occasions of our meeting, invariably neatly coiled up in its characteristic figure-of-eight pose, two or three feet or even more above the ground, in a cactus or dwarf acacia or even the lower branches of a babul tree. I sent one of these specimens to the Bombay Natural History Society for formal confirmation of my identification and record, though no one who has learned to recognise snakes by their scale characteristics should make a mistake.

Here it may be as well to emphasize the necessity, for any observer who desires to know his snakes, of studying—with the aid of authority on the subject—the character and arrangement of their scales. Reliance on size and colouring will be found a broken reed. The trouble is that no live snake at liberty is going to allow you to count his scales, and the wise man will use the stick first and look up the book afterwards.

Once you know the phoorsa, however, you should, provided you can obtain a good look at him, always know him alive or dead; and a very live little reptile he is when alive! The hiss of the average snake is a noise produced by the mouth. The phoorsa has thought of another way. The scales on his back are roughened by means of a patent saw-like keel in the middle of each; hence one of his names, 'the Saw-scaled Viper.' When disturbed he works his coils in a rotating movement which, by the scraping together of these keels as the sides of the body rub against each other, produces a peculiar, half crackling, half hissing sound that is surprisingly loud and is as distinctively characteristic of this viper as is its figure-of-eight attitude.

While the phoorsa, as already mentioned, is not infrequently to be seen—at any rate in North Gujarat—coiled up in the branches of a bush or low tree, it is of course normally a ground snake, most abundant in sandy or rocky country. When Kipling writes of 'Karait, the dusty brown snakeling that lies for choice on the dusty earth', his description fits the phoorsa even better than it does the krait. It was a phoorsa in the dust that once gave me an opportunity of putting to a practical test one of the most advertised cures for snake-poisoning—permanganate of potash.

It was at a shoot in Kathiawar. Our cars were getting ready to move away and the preparations of one driver had taken him underneath his 'bus'. Suddenly he wriggled out, looking very frightened —bitten by a snake! The little brute was speedily driven out and slain, proving to be a phoorsa. The next move was a dive into my car for the cartridge-bag in which I always carried a little tin of permanganate of potash in readiness for just such an emergency, though occasion for its use there had never been before. I do not suppose more than two minutes had elapsed before I had made, with a sharp knife, a fairly deep cross incision at the site of the wound—the two fang punctures were clearly visible close to the base of the victim's thumb. This done I rubbed in the permanganate crystals thoroughly. In the event practically no symptoms of poisoning developed, and I have no doubt that the prompt action was the means of saving the man from a bad time, possibly from death; statistics show that the bite of this snake has fatal results in about twenty-five per cent of cases.

This instance was a particularly favourable one for the operation of the cure. The point to be made clear is that it was the promptitude which counted. Permanganate acts by neutralizing the dangerous constituents of the actual venom. To be of any use, therefore, it has to be brought into direct contact with the venom itself before the latter has been dissipated in the blood stream. If in this particular case action had been delayed by half an hour, or even twenty minutes, it would almost certainly have been quite useless.

It cannot be too strongly emphasized that there is no known cure for snake-poison, once it has entered the blood stream, except antivenine prepared from a serum of the venom of the particular species of snake responsible for the bite. There are no doubt measures which a medical man can take that may be helpful in border-line cases. But it may safely be maintained that the great majority of recoveries from snake-bite poisoning are due to the simple fact that the amount of venom injected was not enough to constitute a fatal dose. The old-fashioned belief dies hard that the best thing to do is to fill the victim up with alcohol. In the modern view this is a dangerous error, and the practice much more likely to do harm than good.

From time to time, usually during the monsoon season, a commotion in one's compound or back premises is accompanied by the cry of 'Sámp hai! Bara Sámp! (Big Snake!)', and presently the bearer appears, either to beg the Sahib to come forth and deal with the intruder, or to invite attention to the sweeper who, at the foot of the verandah steps—which his 'untouchable' form must not pollute by ascending—holds out in deprecating triumph a stick, from which dangles the limp corpse of the enemy; occasionally krait or cobra, though more often an entirely harmless species. But to one's retainers all snakes are deadly. Or, if at times prepared to admit that there may be exceptions, they deem it wiser to act on the eminently sound principle, which we have already advocated, of making sure first and inquiring afterwards.

This does not, of course, apply to the Brahmin, who looks upon the cobra with veneration; or to the Jain, to whom the taking of any life whatever is a crime. Should venomous snakes become too abundant round about a gentleman's domicile to be entirely comfortable, there is usually no difficulty about having recourse to the snake-charmer. This individual will always be prepared, for a consideration, to beguile with sweet music that inconvenient cobra from its hole, and convey it, without ostentation, to the sufficiently distant compound of a neighbour. Whether the cobra so beguiled had or had not been previously put into that hole by the snake-charmer himself, is a matter upon which I should not venture to hazard an opinion.

A few people in India learn to identify the principal venomous snakes; none but the professed naturalists know anything about the harmless ones. Yet of these there are many more species, from the magnificent Python to the slender Green Whip-snake, or the barred Wolf-snake who is liable to suffer for a superficial resemblance to the deadly krait. Then there is the big Dháman, or Rat-snake, the virulent glance of whose eye at milking-time, I have been solemnly assured, will dry up the udders of a cow—to say nothing of the Amphisboena, who bears a head at each end of his body! It will be gathered that there is quite a lot to be learned about the non-venomous snakes. But for most people it will always remain the venomous minority alone that matters.

Of this venomous minority in India there are—apart from the Sea Snakes—but four species at all generally common whose bite is liable to prove fatal to a human being, the four I have already mentioned: cobra, krait, daboia and *Echis*. One cannot but wonder why this should be so. The existence, indeed, of snakes furnished with an elaborate apparatus for the injection of deadly poison, has always been one of nature's mysteries. The majority of the race, living a similar life to the specialised minority, feeding upon similar prey and subject to similar dangers, seems to get on perfectly well without any such equipment. The Grass Snake of the home country, for example, appears to make just as much a success of life as does the Adder. Why then should the few be provided with a death-dealing weapon of appalling efficiency, which the many neither need nor possess but by reason of which they must share universal obloquy?

The question is one to which science has as yet no answer. But perhaps the world need no longer look upon as wholly vile a creature that—by means of the very venom whose possession has hitherto damned it—now comes forth in unexpected colours as a benefactor of mankind! For, while the property of coagulating blood, possessed by certain snake venoms—notably that of the daboia—has long been known, it is but recently that medical science has learned to make practical use of this property. This has been done in perfecting a new treatment for haemorrhage and, what is particularly interesting, in the successful application of the treatment to cases of that uncommon and peculiar complaint, haemophylia—sufferers from which are vulgarly known as 'bleeders'—in which the patient has to be handled like delicate china lest he bleed, perhaps to death.

Not, of course, that the newly discovered treatment for serious haemorrhage constitutes the first beneficial use to which snake venom has been successfully applied. The manufacture of an effective antidote to snake-bite poisoning, in the form of an anti-toxic serum prepared from the venom itself, is now a good many years old. But the use of such a serum as a cure for the effects of snake-bite is, after all, but a practical modern application of the ancient nostrum of a hair of the dog that bit you! Were there no bite, there were no need for a cure. For the viper today to come to the aid of humanity, and assist in the treatment of a malady for which he is in no way responsible, is surely a very different matter. True, that his assistance is vicarious; yet does it not warrant our looking with more kindly eyes upon a creature who, loathed and hated of mankind and made the symbol of all that is vile, has through the ages awaited the dawning of the day which should see him acclaimed a benefactor of the human race? Our vision cleared as to his merits, may we not now permit ourselves to recognise in the snake a beauty of form and colouring that has in the past been obscured by a veil, the creation of our own mental attitude towards him?

Observe a grass snake in the woodland, as it glides away before our approach; can we fail to admit the grace in its movements? And the formidable daboia in the Zoo—'What a flat evil-looking head!'—the exclamation will out; is it merely the old prejudice not yet wholly dissipated? Whether or no, his old coat recently sloughed, one cannot deny the brilliancy of colouring and pattern of the new one, with its triple chain of large orange-brown diamonds outlined in greenish black or deep purple and contrasting white. Whether tenacious of his rights or merely sluggish—he is a somewhat corpulent person—the daboia, when he lies in your path, does not put himself out greatly to make way for you. If you tread upon him he will retaliate to some purpose, and I remember a particular individual in captivity who would strike viciously at anyone approaching his cage. But in a state of freedom he is, unlike some of his kind, the King Cobra for example, not usually aggressive of disposition, and will give you fair warning of his presence with a resounding hiss that is meant to be heard. Not his the blame if you ignore it.

Once, before one had learned to recognise a benefactor in 'that fell speckled snake', an altercation with a large daboia that I met out shooting ended in the demise of the latter, a specimen, as it turned out, of the female sex. The funeral rites disclosed no less than 53 unhatched eggs from which, but for my untimely interference, there would presently have emerged 53 infant vipers, each with curved fang and poison gland and forked tongue all complete.

My pen has been running amiably on, some spirit of conciliation in the air. But the mental vision of that multiple reptile progeny gives one pause. It may be that the daboia wears a beautiful coat, and will not bite unless provoked. It may be that human science can use the poison from under his lips to bestow life rather than death. Yet—flat scaly head and flickering forked tongue! I fear me that a serpent remains a serpent, cursed above every beast of the field.

BOTANICAL EXPLORATIONS IN THE BHILLANGNA VALLEY OF THE ERSTWHILE TEHRI GARHWAL STATE—II

BY

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INTRODUCTION

In continuation of Masar Tal Lake (10,746 ft.) ridge in the Bhillangna Valley there is a region of lakes known as Sahsru Tal situated on the water parting ridge of the rivers Balganga and Bhillangna. There are a number of lakes here, one big one situated at 16,897 ft. having a perimeter of about one mile. All these lakes are snow-fed. The plants from this region were collected in the month of September and my specimens were identified at the Central National Herbarium at Calcutta.

LIST OF SPECIMENS COLLECTED

The plants in the following list have been collected from Sahsru Tal which is in continuation to the list previously given. The reference numbers given after each specimen refer to herbarium sheets possessed by the author. Every effort has been made to adjust the nomenclature of the plants according to the latest findings on the subject; plants marked with an asterisk have not been described by Collett in FLORA SIMLENSIS.

RANUNCULACEAE

Aconitum heterophyllum Wall.

Erect herb, with spurred green flowers having purple veins, at Helsi 11,000 ft. (*Gupta* 314, 374)

Delphinium vestitum Wall.

Hairy herb, with blue spurred flowers, at Masar Tal lake at 9,000 ft. (*Gupta* 301)

FUMARIACEAE

Corydalis meifolia Wall.

Herb, about 1 ft. at Bayani 14,500 ft. (*Gupta* 341)

HYPERICACEAE

Hypericum elodeoides Choisy.

Herb, 1–2 ft. flowers yellow with black dotted petals, common at Kyarki 15,000 ft. (*Gupta* 282)

GERANIACEAE

Impatiens roylei Wall.

Erect herb, with spurred pale pink flowers at Bayani 14,500 ft. (*Gupta* 321)

RUTACEAE

Boenninghausenia albiflora Reichenb.

Herb with white flowers, very common upto 9,000 ft. at Masar Tal. (*Gupta* 302)

Skimmia laureola Sieb. & Zucc.

Shrub, with yellow flowers, leaves having strong orange-like smell when crushed, common at Masar Tal on the sides of the lake. (*Gupta* 306)

RHAMNACEAE

Zizyphus mauritiana Lamk.

Shrub, with branches spreading and drooping at the ends at 6,000 ft. (*Gupta* 245, 142)

ROSACEAE

Potentilla argyrophylla Wall.

Herb, about 2 ft. with yellow flowers at 16,000 ft. Kyarki. (*Gupta* 209)

Potentilla microphylla Don

Herb, about 3 ft. with minute flowers at Helsi 14,500 ft. (*Gupta* 342)

Potentilla fulgens Wall.

Hairy herb with yellow flowers, common upto 10,000 ft. Masar Tal. (*Gupta* 361, 386)

SAXIFRAGACEAE

Saxifraga diversifolia Wall.

Herb. 1 ft. with yellow flowers at 11,000 ft. (*Gupta* 371, 378)

Parnassia nubicola Wall.

Herb, with white solitary terminal flowers, common upto 15,000 ft. (*Gupta* 328)

ONAGRACEAE

***Epilobium roseum** Schreb.

Herb, about 1 ft. at 9,000 ft. near Masar Tal lake. (*Gupta* 303)

BEGONIACEAE

***Begonia laciniata** Roxb.

Herb, about 2-3 ft. at Bayani 14.5000 ft. (*Gupta* 337)

UMBELLIFERAE

Sanicula europea Linn.

Herb, with minute white flowers at 9,000 ft. near Masar Tal lake (*Gupta* 287)

Pimpinella diversifolia DC.

Hairy herb, 2-3 ft. with white flowers at 9,000 ft. near Masar Tal lake. (*Gupta* 300)

Selinium tenuifolium Wall.

Herb, 2-8 ft. with white flowers at 11,000 ft. (*Gupta* 310)

Angelica glauca Edgew.

Herb, with white purple flowers at 11,000 ft. (*Gupta* 351)

***Pleurospermum candollii** Benth.

Herb, about one ft. at Sahsru Tal 16,000 ft. (*Gupta* 319, 340)

Pleurospermum angelicoides Benth.

Herb, 3-4 ft. at 14,000 ft. (*Gupta* 327)

RUBIACEAE

Gallium asperifolium Wall.

Weak herb with trailing stem, flowers red upto 10,000 ft. (*Gupta* 100)

Gallium rotundifolium Linn.

Herb, with trailing stem, flowers white tinged with green upto 9,000 ft. (*Gupta* 101)

Rubia cordifolia Linn.

Climbing herb, with small red flowers at 8,000 ft. (*Gupta* 103)

VALERIANACEAE

Valeriana wallichii DC.

Herb, with white flowers tinged with pink, roots having a characteristic smell, at 15,000 ft. (*Gupta* 280)

Nardostachys jatamansi DC.

Herb, about 6-7 in., roots having characteristic smell, at 11,000 ft. (*Gupta* 335, 373)

DIPSACACEAE

Dipsacus inermis Wall.

Shrub, with numerous white flowers crowded in terminal heads at Masar Tal 10,000 ft. (*Gupta*)

Morina longifolia Wall.

Herb, 2-3 ft with deep pink flowers at 14,500 ft. (*Gupta* 326)

COMPOSITAE

Erigeron multiradiatus Benth.

Hairy herb, with flowers having dark purple ray florets at 14,500 ft. (*Gupta* 320)

Gnaphalium luteo-album Linn.

Woolly herb, with bright yellow flowers at 16,000 ft. near Sahsru Tal. (*Gupta* 266)

Anaphalis nubigena DC. var. **polycephala**

Cottony herb, with white flowers at Sahsru Tal 16,000 ft. about 1-3 ft. high. (*Gupta* 231)

Anaphalis triplinervis Clarke

Cottony herb, 1-2 ft. with white flowers. (*Gupta* 277)

Artemisia parviflora Roxb.

Erect shrub, like herb, 1-3 ft. with flowers tinged with green at Masar Tal. (*Gupta* 292)

Artemisia vulgaris Linn.

Hairy herb, 3-6 ft. common upto 14,000 ft. (*Gupta* 294, 336)

Senecio amplexicaulis Wall.

Herb, about 3 ft. high, with yellow flowers near Masar Tal lake at 9,000 ft. (*Gupta* 345, 355)

Senecio chrysanthemoides DC.

Herb, 2-3 ft. flowers with conspicuous yellow ray-florets. (*Gupta* 350)

Senecio arnicoides Wall.

Herb, 2-3 ft. with yellow flowers at 9,000 ft. (*Gupta* 395)

Saussurea taraxicifolia Wall.

Herb, with cottony stem, 1-6 in. with dark purple flowers at 11,000 ft. (*Gupta* 360)

Saussurea hypoleuca Spreng.

Herb, 2-5 ft. with dark purple flowers at 14,000 ft. (*Gupta* 333)

Saussurea gossypiphora Don

Herb, about 8 in. cottony. (*Gupta* 322)

Saussurea kunthiana Clarke

Herb, about 1 ft. at 14,000 ft. (*Gupta* 339)

Saussurea lappa C. B. Clarke

Herb, with yellow flowers 11,000 ft. (*Gupta* 289)

Saussurea obvallata Wall.

Herb, 1–2 ft. at Sahsru Tal 16,000 ft. (*Gupta* 338)

Cremanthodium oblongatum C. B. Clarke

Herb, 1–2 in , flowers yellow at 14,500 ft. (*Gupta* 324)

Tanacetum longifolium Wall.

Strongly scented herb, with bright yellow flowers at Kyarki 15,000 ft. (*Gupta* 264)

CAMPANULACEAE

Cynanthus lobatus Wall.

Herb, about 6 in. at Bayani 11,000 ft. (*Gupta* 336, 382)

PRIMULACEAE

Primula involucrata Wall.

Herb, about 1 ft. at Sahsru Tal 16,000 ft. (*Gupta* 318)

Primula macrophylla D. Don var. **macrocarpa**

Herb, about 8 in. at Kyarki 14,000 ft. (*Gupta* 325)

Primula sp.

Herb 1–2 ft. at Bayani 11,000 ft. (*Gupta* 346)

Lysimachia alternifolia Wall.

Hairy herb, 6–12 in. with yellow flowers at 6,000 ft. (*Gupta*)

GENTIANACEAE

Swertia purpurescens Wall.

Herb, 1–3 ft., flowers with pale red purple corolla having ring at the base, at 16,000 ft. (*Gupta* 283, 372)

Swertia alternifolia Royle

Herb, 2–4 ft. with lurid grey flowers at Bayani 11,000 ft. (*Gupta* 357)

Halenia elliptica D. Don

Herb, with pale blue flowers at Sahsru Tal 16,000 ft. (*Gupta* 268)

SOLANACEAE

Solanum nigrum Linn.

Herb, 12–18 in. with small white flowers upto 8,000 ft. (*Gupta* 134)

Datura stramonium Linn.

Erect herb, 2–4 ft. with white flowers 4–7 in. at 4,000 ft. (*Gupta* 199, 246)

SCROPHULARIACEAE

Pedicularis gracilis Wall.

Herb, with pink flowers at Bayani 11,000 ft. (*Gupta* 278)

Pedicularis pectinata Wall.

Herb, 6–18 in., with pink spicate flowers at 11,000 ft. (*Gupta* 389)

Pedicularis pectinata Wall. var. **palans** Prain.

Herb, about 20 in. with pink spicate flowers (*Gupta* 307)

Picorrhiza kurooa Benth.

Herb, about 7 in., at Sahsru Tal 16,000 ft. (*Gupta* 330)

LABIATAE

Colebrookea oppositifolia Benth.

Herb, flowers with small purplish corolla at Tehri. (*Gupta* 104)

Phlomis bracteosa Royle

Hairy erect herb, 1–5 ft. with blue-purple flowers at Masar Tal 9,000 ft. (*Gupta* 263)

Brunella vulgaris Linn.

Hairy herb, 4–12 in. with violet-purple flowers at Sahsru Tal 16,000 ft. (*Gupta* 279)

Origanum vulgare Linn.

Herb, 1-3 ft. with small pink flowers at Masar Tal 9,000 ft. (*Gupta* 297)

Stachys sericea Wall.

Silky herb, with pink flowers at Bayani 11,000 ft. (*Gupta* 353)

Leucas lanata Benth.

White woolly herb, with small axillary flowers in whorls, common upto 8,000 ft. (*Gupta* 232)

Leucas cephalotes Spreng.

Hairy herb, 1-3 ft. with white flowers in terminal whorls at 4,000 ft. (*Gupta* 261)

AMARANTACEAE

Cyathula tomentosa Moq.

Woolly herb, with white flowers in long spikes (*Gupta*)

Achyranthes aspera Linn.

Hairy undershrub, with dull green flowers in terminal spikes (*Gupta* 231)

Achyranthes bidentata Blume

Undershrub, with slender spike 4-5 in. long, having dull green purplish flowers. (*Gupta* 203)

POLYGONACEAE

Polygonum amplexicaule Don

Herb, 2-3 ft. with deep red flowers at Sahsru Tal 16,000 ft. (*Gupta* 305)

Polygonum alatum Buch.-Ham.

Herb, 3-6 ft. with white purplish flowers at Bayani 11,000 ft. (*Gupta* 376)

Polygonum polystachyum Wall.

Shrub, with white pinkish flowers at Sahsru Tal at 16,000 ft. (*Gupta* 273)

Polygonum affine Don

Herb, about 6 in. with pink flowers at Sahsru Tal 16,000 ft. (*Gupta* 317)

Polygonum vaccinifolium Royle

Herb, about 6 in. with pink flowers at Sahsru Tal 16.000 ft. (*Gupta* 308)

THYMELAEACEAE

Daphne papyracea Decne.

Shrub, 5-8 ft. with white liliac flowers upto 8,000 ft. near Masar Tal. (*Gupta*)

EUPHORBIACEAE

Euphorbia pilosa Linn.

Milky herb, with small flowers in a cup-shaped involucre with yellow glands. (*Gupta* 375)

ORCHIDACEAE

Satyrium nepalense Don

Herb, 6-24 in. with pink fragrant flowers ; root tuberous ; at 11,000 ft. (*Gupta* 380)

SCITAMINEAE

Roscoe purpurea Smith

Herb, with purple flowers at 16,000 ft. (*Gupta* 265)

Cautleya spicata Baker

Herb, leaves 10-15 in. long, with yellow flowers in terminal spikes at Masar Tal 9,000 ft. (*Gupta* 290)

LILIACEAE

Allium wallichii Kunth

Bulbous herb, flowers with purple rotate perianth at Bayani 11,000 ft. (*Gupta* 315, 347)

Asparagus curillus Ham.

Herb, with small white flowers. (*Gupta* 334)

JUNCACEAE

Juncus sphacelatus Decne.

Perennial herb, with brown flowers. (*Gupta* 296)

CYPERACEAE

Carex nubigena D. Don

Herb, with pale spike, glume with female flowers midrib having prominent white margins at Sahsru Tal 16,000 ft. (*Gupta* 281)

Carex filicina Nees

Herb, common at Sahsru Tal 16,000 ft. (*Gupta* 284)

Hemicarex hookeri Boeck.

Herb, with slender stem, 4-12 in., spike linear and narrower at the base, at Sahsru Tal 16,000 ft. (*Gupta* 329)

Cyperus nubigena Don

Herb at 16,000 ft. (*Gupta* 281)

GRAMINEAE

Sporobolus indicus R. Br.

Perennial herb, 1-3 ft. with brown spikelet at Sahsru Tal 16,000 ft. (*Gupta* 285)

Avena barbata Brot.

Herb, common at Bayani 11,000 ft. (*Gupta* 387)

Phleum alpinum Linn.

Herb, common at Kyarki 14,500 ft. (*Gupta* 274, 223)

Andropogon gryllus Linn.

Perennial herb, 1-5 ft. forming hard spikelet in threes. (*Gupta* 304)

Andropogon sp.

Perennial herb at Kyarki 14,500 ft. (*Gupta* 331, 332)

Koeleria cristata (L.) Pers.

Perennial herb with tufted stem, spikelets tinged with purple at Sahsru Tal 16,000 ft. (*Gupta* 312)

Agrostis canina Linn.

Herb at Bayani 11,000 ft. (*Gupta* 263)

Agrostis micrantha Steud.

Herb at Sahsru Tal 16,000 ft. (*Gupta* 270)

Glyceria tonglensis Clarke

Perennial herb, creeping on wet ground, spikelets few, awnless, green tinged with purple at 14,500 ft. (*Gupta* 343)

Danthonia kashmiriana Ju. S.

Herb, at Bayani 11,000 ft. (*Gupta* 352)

Paspalum sanguinale Lamk. var. **cruciatum.** (Nees) Hook.

Herb, 6 in. to 3 ft. at Sahsru Tal 16,000 ft. (*Gupta* 267)

Deyeuxia sylvatica Kunth

Herb, at Sahsru Tal 16,000 ft. (*Gupta* 309)

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STUDIES ON NON-INSECT ENEMIES OF LAC, WITH SPECIAL REFERENCE TO SQUIRRELS AND BIRDS AS SERIOUS SEASONAL PREDATORS

BY

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(*With a text figure*)

INTRODUCTION

One of the factors limiting production of lac is the prevalence of its enemies estimated to account for a destruction of over 40% of living lac cells in an average crop (Negi 1942). Most of these enemies are themselves insects and they fall under either of the two categories, namely parasites and predators. The former belong to the superfamily Chalcidoidea and number eight in all. The damage done by all these parasites put together does not normally exceed ten per cent of the lac cells. The predators, on the other hand, do considerable damage to lac crops, and the larvae of the two important lepidopterous predators, *Eublemma amabilis* Moore and *Holcocera pulverea* Meyr, together have been known to damage thirty to thirty-five per cent of lac cells. The loss caused by the predatory larvae of lacewing flies (*Chrysopa madestes* Banks and *C. lacciperda* Kimmins, etc.) is comparatively low, but instances are not lacking of outbreaks on an epidemic scale resulting in severe damage to young developing crops. Apart from the commonly prevalent insect enemies enumerated above, and the damage caused by them, serious attention to a new type of damage was drawn from 1940 onwards when partial artificial defoliation of *palas* (*Butea monosperma*) in *Baisakhi* crop (Negi 1942) succeeded in considerable measure in preserving broodlac against summer heat and drought, and it was found that many of the lac cells so saved were damaged by some enemies. As a result of investigation, a few enemies other than insects have been recently noted which cause serious damage at the most critical time of the crop. This paper incorporates investigations carried out on these new non-insect predatory enemies.

LOCALITY, TIME OF OCCURRENCE, AND TYPE OF DAMAGE

This new type of damage to lac cells is being observed on *palas* (*Butea monosperma*) every year in the Bihar Government Forest at Kundri (Palamau District) and it is characterised by both the time of occurrence and its nature. Kundri experiences a very severe summer with the day temperature sometimes shooting up to 120°F. in May–June; hence, at Kundri the Baisakhi crop suffers to a great extent every year, particularly from the point of view of brood preservation. Towards the end of May, and in June, a very heavy mortality of lac insects occurs due to the intense summer heat and only a very low percentage of the insects survives the effect of heat. It is about this time that the new type of damage to the small percentage of surviving female lac insects is observed. Thus the damage occurs at a very critical time of the crop and a considerable part of the small quantity of surviving broodlac is lost.

As regards the nature of damage, it is quite typical in that the mature cells are broken open and the living female insects inside pulled out and devoured. More often the insects are completely removed from the tests, but occasionally portions of their bodies are left behind. The resinous test-covering is normally found opened with a horizontal or vertical circular cleavage with the result that the lac-encrusted twig looks as if partially scraped. On twigs where all the lac cells have been damaged, only nearly semi-spherical cups of the lower portion of the lac tests are found attached to the twig as shown in the figure. In a few cases, the cleavage is rather irregular also.

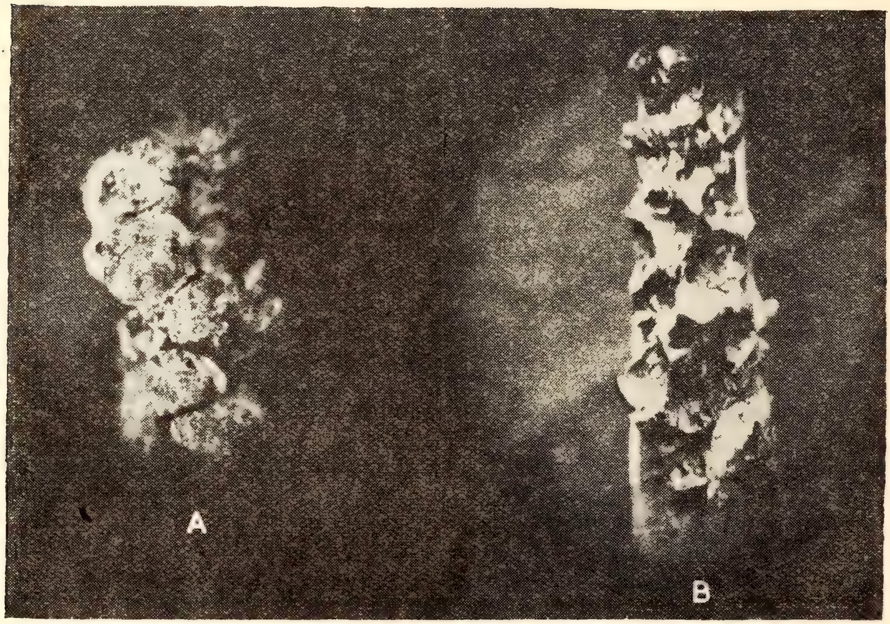

Fig.—Lac encrustation on twigs

A. Free from damage B. Damaged

In addition to such damage observed on the *Baisakhi* crop, a similar type of damage is also noticed in the maturing *Katki* crop to a limited extent at Kundri, and it is mostly confined to spots showing predator damage. At the Institute field area in Hesal near Ranchi, *Kusum* crops also show similar damage, particularly the maturing *Jethwi* crop in June-July. On *Kusum* and in *Katki* crop where the encrustation is comparatively more continuous, the damaged portion of lac sticks looks as if partially scooped out with a sharp instrument. In the case of *Kusum*, damage is not merely confined to mature lac while still on the trees, but was observed somewhat even more pronounced in broodlac sticks that were tied on to the trees for infection. In several cases the damage was also caused to broodlac enclosed within 60 to 80 mesh brass wire net baskets which had been cut open at places.

METHOD OF STUDY

The fact that the broodlac and the brass wire net baskets used to enclose them were both damaged was an indication that rodents like squirrels that could climb the trees, could possibly be chiefly responsible for such type of damage. Similarly, birds that possess strong beaks, like woodpeckers, could also possibly inflict such damage to the exposed lac. In the past, both these animals were suspected to cause some accidental and practically negligible damage (Glover 1937). Moreover, as these animals are seen freely visiting the lac-bearing trees at the time when the damage is also noticed, detailed investigations on their connection with it were initiated during the summer of 1954 and continued during 1955 and 1956 at Kundri Forest where the damage is of a very serious nature. To determine the culprits responsible, three methods of study were employed, namely, examination of gut contents, field observations on their behaviour, and artificial feeding of captives. The last method was employed only in the case of squirrels and woodpeckers.

EXAMINATION OF ALIMENTARY CANAL

During the period of study 50 squirrels and 58 birds were collected by shooting, in either June or October, at the time of maturity of the *Baisakhi* and *Katki* crops respectively. The specimens were preserved in four per cent formalin so that their stomach contents could be carefully examined in the laboratory for the presence of lac insects, lac resin pieces and other insects associated with lac cultivation. The examinations were carried out very thoroughly part by part of the entire alimentary canal of these specimens. In all 36 squirrels and 58 birds belonging to 16 species were examined. The summary of the results is furnished in Tables I and II, separately for squirrels and birds respectively.

Examination of the stomach contents showed that the squirrels and birds had consumed a variety of food from both animal and vegetable sources. The food inside the stomach was in different stages of digestion. Most of the vegetable matter was in an advanced state and could not be correctly identified. Whenever lac insects were found, they were observed to be either entire or almost entire, or in fragments if they had undergone digestion. Nevertheless, the strongly chitinised portions of anal tubercle and the brachial tubes attached to such fragments could be clearly made out and they served to count the number of insects consumed correctly.

Squirrels. All the 50 specimens shot during the two seasons were the common Fivestriped Palm Squirrel (*Funambulus pennanti* Wroughton). The results of examination of their stomach contents (Table I) reveal that squirrels of the June seasons had consumed lac insects in fairly large numbers. Adult female lac insects, ranging between 1 and 134 in number, were traced in the stomachs of 20 out of 26 (76·9%) squirrels of the June season, the majority being found either entire or practically entire. Lac larvae ranging between 1 and 14 in number were found in 10 specimens. Small broken pieces of lac resin in considerable quantity were found in as many as 19 specimens. Further, whenever adult female lac insects had been consumed in sufficient numbers, eggs from them were found freely floating in good numbers in the wash liquid of the stomach contents. Thus, evidence was available in 23 cases out of 26 (88·5%) that squirrels had tampered with the lac crop in the June season.

The fact that adult female lac insects are found in large numbers and also almost entire in form, along with small pieces of lac cells in the stomach contents of the squirrels of the June season, is a clear indication that during this season these animals have gnawed open the mature lac cells and pulled out and devoured the lac insects whole. This is also in corroboration of the typical nature of the damage to lac sticks described above and found about this time of the *Baisakhi* crop.

Among other insects associated with lac, which were traced in June specimens of squirrels, were two heads of lepidopterous larvae in a mutilated condition, in two specimens. One of them resembled *H. pulverea* and the other *E. amabilis*. In a third specimen two trunks of a caterpillar resembling *E. amabilis* were found. The vegetable matter consumed was comparatively less in quantity and, among other things, included some seeds and also probably the pulp of *Jamun* fruit (*Eugenia jambolana*).

The stomach content analysis of squirrels of the October season revealed that adult female lac insects had been consumed in fewer numbers, varying from 2 to 7, and again by a fewer number of individuals. Only 3 out of 10 specimens of the October season had consumed adult female lac insects, whereas lac predators had been consumed by as many as 5 specimens and in fairly large numbers, ranging between 1 and 57. This clearly indicates that during the October season squirrels visit the maturing lac crop mainly for the lac predators. This again is in corroboration of the fact that damage to broodlac then is comparatively less and limited to areas of predator infestation. Thus, in the October season the damage to lac appears to be more of an incidental nature.

Birds. In all 58 birds representing 16 species were collected for the purpose of stomach content analysis, as follows :

Species	*No. of specimens examined*
Mahratta Woodpecker [*Dryobates mahrattensis* (Latham)]	11
Goldenbacked Woodpecker [*Brachypternus benghalensis* (Linn.)]	10
Redvented Bulbul [*Molpastes cafer* (Linn.)]	5
Rufousbacked Shrike [*Lanius schach* (Linn.)	6
Coppersmith [*Megalaima haemacephala* (Müller)]	3
Wood Shrike [*Tephrodornis pondicerianus* (Gmelin)]	1
Jungle Babbler [*Turdoides somervillei* (Sykes)]	1
House Sparrow [*Passer domesticus* (Linn.)]	4
Indian Pitta [*Pitta brachyura* (Linn.)]	1
King Crow (*Dicrurus macrocerous* Vieillot)	3
Common Iora [*Aegithina tiphia* (Linn.)]	2
Common Weaver Bird [*Ploceus philippinus* (Linn.)]	1
Crow-Pheasant [*Centropus sinensis* (Stephens)]	1
Golden Oriole [*Oriolus oriolus* (Linn.)]	1
Common Myna [*Acridotheres tristis* (Linn.)]	2
Small Minivet [*Pericrocotus peregrinus* (Linn.)]	6
Total	58

The results of the examination (Table II) revealed adult female lac insects to be present in the stomachs of 4 out of 10 specimens of the Goldenbacked Woodpecker, one out of 11 specimens of the Mahratta Woodpecker, and 1 out of 5 specimens of the Redvented Bulbul. The number of adult lac insects taken ranged from 1 to 11 in the case of Goldenbacked Woodpecker, and 22 and 5 respectively in the case of Mahratta Woodpecker and the Redvented Bulbul. Lac larvae in small numbers were recovered from the two species of woodpecker, the Redvented Bulbul, Rufousbacked and Woodshrikes, Coppersmith, House Sparrow, King Crow and Small Minivet, suggesting that they had been picked up accidentally while pecking at the bark in search of food. Broken resinous pieces of the lac test were observed only in the case of the woodpeckers, the Rufousbacked Shrike and the Redvented Bulbul, and it is suggestive of the fact that these birds had deliberately opened the lac test in search of their insect food which may be either the adult lac female or the predatory enemies of the lac insects.

Of the other insects associated with lac, two heads of lepidopterous larvae resembling *E. amabilis* were recovered from one specimen of Mahratta Woodpecker, and one head resembling that of *H. pulverea* from one specimen of the Rufousbacked Shrike. Two *E. amabilis* larvae were traced in a second specimen of the Mahratta Woodpecker. A third specimen had consumed as many as 32 larvae, 12 pupae and one adult of *E. amabilis* and 3 pupae of *Elasmus claripennis*.

It is of interest to note here that the birds were generally found only in small numbers in the forest, and the individuals under each of the species were still fewer. This, as well as the fact that they do not devour the lac insect in large numbers, clearly indicates that the damage to broodlac by birds is only minor, and the major part of the observed damage, particularly in the summer season, is inflicted by the squirrels.

FIELD OBSERVATIONS ON SQUIRRELS AND BIRDS AT KUNDRI

General observations on the habits and behaviour of the above, and the way they damage the lac crop, were started in June 1954 and detailed observations were made during the day-time from 5 a.m. to 7 p.m. in June 1955, in the summer season when maximum damage is done.

Squirrels. These animals come out of their hiding places at daybreak and are found actively feeding in the cool early hours of the morning. They run about freely on the ground nibbling at some thing or other here and there, and also quite often climbing up the *palas* (*Butea*) trees. They are seen to nibble at the earthen termite tunnels found on the ground or the tree-trunks. When alarmed they immediately run up the nearest tree and hide themselves in the bushy branches. Being very active, shy and alert, it was difficult to observe their normal behaviour in the field. As the day becomes hotter, their activity also slows down, and they are rarely seen on the ground between 10 a.m. and 4 p.m. They were, however, sometimes seen during midday on the tree-tops resting on the branches, with limbs outspread and completely relaxed. While thus resting it is hardly possible to detect their presence on the tree. They become active again towards the evening and are either found on the ground or going from tree to tree in search of food. They seem to be less active during cloudy and rainy days

In Kundri forest it is generally noticed that on the trees adjoining the cultivated fields the lac insects thrive in larger numbers and there is also a comparatively greater concentration of squirrels near such trees along the edge of the fields. After about 10 days hunting and shooting of the squirrels in the area, it was noticed that their population had considerably decreased and that they were rarely seen in the locality.

This species litters at least once[1] during June–July as young ones were noticed in June and four just-born blind ones were recovered from a nest on a *palas* tree in July.

Mode of feeding on lac crop: On about half a dozen occasions, observations were made from a distance [without binoculars], when the squirrels were feeding on lac encrustations. They move about the twig bearing lac, and now and then stop to feed. They bite on a fairly large number of cells on a twig before proceeding to the next. They visit almost every twig on a branch and do considerable damage to the lac cells, sometimes almost completely eating away all the cells found on the twig. Usually they feed on the top branches rather than on the lower ones, and again they prefer twigs with thick foliage as these provide sufficient cover for them to feed unobserved. Lac on shoots having lac cells neither too closely situated nor too sparse, were damaged more often than the rest.

In addition to direct observations made from a distance, the shoots on which the squirrels were feeding were collected and examined immediately after shooting the animals. The damage was observed to be quite fresh and wet smears of the 'blood' of the lac insects on the damaged encrustations was also clearly visible. Besides, the animals shot also showed the red lac dye stain on the mouth, the tongue, the paws and sometimes on the belly as well, thus confirming that the squirrels feed on live mature lac insects.

Birds. The birds frequenting the Kundri area are the common species found in scrub-and-bush country, light deciduous forests and orchards, etc.; they include both those strictly arboreal and those essentially ground-loving in habit. At Kundri these birds were found to be very active from 5 to 8 a.m. and again later in the day from 5 to 7 p.m. During the interval they were found resting in bushes or on tree branches, and showed little activity and hardly moved from place to place. They were also less active during cloudy and rainy weather. Unlike in the case of squirrels, the birds were found more concentrated in the interior of the forest than along the border. They became rarer even in the interior after a few days of disturbance by shooting. They seemed to have shifted to an undisturbed corner of the forest.

Damage to lac: As far as could be observed, no bird except the woodpeckers was seen pecking at the lac encrustation. Twigs on which they were found sitting did not show any damage to the lac cells. Even woodpeckers were normally seen to peck on the trunk or thick branches of the tree where there was no lac encrustation at all. In one instance, however, a specimen of the Goldenbacked Woodpecker was seen pecking at a twig bearing lac. The bird was immediately shot and the twig examined for damage. Three to four cells on the twig were freshly damaged and lac dye stain was quite wet on the cells. The damage to the cell was not of the type as noticed in the case of the squirrels but the cleavage was somewhat irregular and more vertical than horizontal. The shot specimen was also immediately examined. The beak and tongue showed the stain of the lac dye, and the stomach contents freshly devoured lac (adult female) insects numbering 8 in all.

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[1] For breeding habits of the Fivestriped Squirrel, see Bannerji (*JBNHS* 53 (2) : 261; 54 (2) : 335. EDS.).

ARTIFICIAL FEEDING OF CAPTIVES

This procedure was adopted for the squirrels and woodpeckers caught alive. Captives confined in cages were offered fresh lac sticks now and then along with some of their normal food, like the fruits of *Ficus glomerata*. In the case of squirrels, almost all the cells on the sticks had been completely damaged and the lac insects inside eaten. The typical damage as found under natural conditions on the trees was exactly reproduced, thus establishing beyond doubt that the squirrel is the chief agent responsible for such damage to mature living lac insects.

The woodpeckers also did damage the lac cells and pecked out the adult female insects, but the damage was characteristically different from that of the squirrels in being more vertical and irregular.

ASSESSMENT OF DAMAGE

As there was a distinct difference in the extent of damage done to the lac crops between trees with better survival and those with poorer survival of lac cells, the assessment was carried out separately on these two groups of trees. The damage was assessed in 1955 and 1956 in the summer season when serious losses occur.

Damage on the basis of lac-bearing twigs: Twenty-five trees at random were selected from each of these two groups (with better survival and poor survival) and all the lac-bearing twigs were cut entire and were classified into one of the following categories according to the damage noticed:

(i) Twigs with all cells dead.
(ii) Twigs with dead and living cells but showing no damage at all.
(iii) Twigs with dead and living cells but showing damage of living cells less than 10%.
(iv) Twigs with dead and living cells but showing damage of living cells between 10 to 25%.
(v) Twigs with dead and living cells but showing damage of living cells between 25 to 50%.
(vi) Twigs with dead and living cells but showing damage of living cells above 50%.

The number of twigs under each category are recorded in Table III (*a*) and (*b*) separately for the two groups of trees. Table III (*c*) gives the figures when all the fifty trees were treated together as one sample representing the whole area.

It is seen from figures under III (*c*) that the twigs showing complete mortality were more (28·1%) in the 1955 summer, as a result of the more severe summer heat then experienced. Directly correlated with this is also the fact that the percentage of twigs damaged is more in the severe summer of 1955 (i.e. 47·8%). Between the two groups of trees with better and poorer survival of lac on them, the damage is heavier on the former than on the latter in both the years. This observation is again in corroboration of the field observations that there was a greater concentration of squirrels near trees having more living lac insects on them.

Damage on the basis of count of cells: For this purpose, three twigs at random from each of the 25 trees under the two groups were selected for stick examination, and the grown-up dead, damaged and living cells were counted. The results are given in Table IV (*a*, *b* and *c*) for the two groups separately and also together when treated as one.

From figures under IV (*c*), it is seen that percentage of mortality of cells was 76·1 in the 1955 summer as against 57·9% in 1956 summer since the latter was comparatively milder. Correspondingly, the percentage of cells damaged out of those living, was 58·4 in 1955 as against 32·8 in 1956. thus establishing that the damage is also more severe if the summer is severe, and that this results in very acute shortage of broodlac.

A comparison of the percentages of damaged cells under *a* and *b* in Table IV shows again similar trends, namely, that the damage was more on trees with better survival of lac resulting from a greater concentration of the squirrels.

SUMMARY

It has been observed for the past several years that female lac insects in *Baisakhi*, and to a small extent *Jethwi*, crops are damaged by certain agencies in summer towards crop maturity. This damage is typical in its nature and time of occurrence. Some damage of this type is noticed also in the case of brood used for infection. The investigations were undertaken in Kundri forest in Palamau District of Bihar where this damage occurs in a very serious form.

The Common Fivestriped Palm Squirrel (*Funambulus pennanti* Wr.) and some species of birds were the only animals found in the locality at the time the damage to the lac occurred, and were suspected of being responsible. In order to ascertain whether they were directly involved the investigations were approached from three angles. Firstly, squirrels and birds visiting the lac bearing trees at the time of damage were shot for examination of their stomach contents. They were collected in June and October when *Baisakhi* and *Katki* crops mature. Secondly, careful observations were made on their behaviour in the field in June, when the maximum damage occurs, to determine whether they feed on lac. Thirdly, captive squirrels and woodpeckers were artificially fed with fresh mature lac sticks to see whether similar type of damage was reproduced.

Both examination of stomach contents of 36 specimens and actual field observations revealed that the squirrels feed voraciously on the lac insects in the June season. Of the specimens examined 76·9% (of June season) had consumed adult female lac insects, as many as 134 insects being found in one specimen. Finally, artificial feeding of the captives clearly demonstrated the typical nature of damage done, and established the link between the damage noticed on the trees and the mature lac insects, lac larvae and eggs found in the stomachs of these animals.

The stomach analysis of 58 birds belonging to 16 species revealed that woodpeckers and bulbuls also damage the maturing lac crop to a small extent.

Having established that the squirrels, and to some extent also birds, do the damage to the maturing lac cells, the extent of damage was assessed in the 1955 and 1956 summer seasons on the basis of both the number of twigs and actual count of cells damaged in representative samples. It was found that the damage to twigs and the cells was more on trees with better survival than on those with heavier mortality of cells (poor survival). In the crop as a whole, lac cells on as many as 28·1% of the twigs were completely dead. Of the rest of the twigs bearing both dead and living cells, up to 47·8% showed damage by squirrels and birds in the 1955 summer. In June–July 1956, when the summer was comparatively milder than in the previous year, the corresponding figures were 22·7% and 29·3% respectively.

Estimation on the basis of lac cells for the entire area revealed that there was a mortality of the mature cells up to 76·1% in 1955 and 57·9% in 1956 due to heat, and of the surviving females as many as 58·4% in 1955 and 32·8% in 1956 had been damaged by these agencies. Thus it may be seen that the damage is all the more acute in view of the heavy mortality of lac cells due to heat.

It is difficult to suggest control measures for preventing this damage. Poison baiting will be uneconomical in large forest areas and also unsafe since domestic animals enter such areas for grazing purposes. It has, however, been found that if the squirrels and birds are regularly shot for about a week, they leave the area. In the case of damage to brood and wire-net baskets, it has been possible to avert this by enclosing them within fairly cheap bamboo baskets that may last for two or three seasons.

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TABLE I

RESULTS OF EXAMINATION OF ALIMENTARY CANAL CONTENTS OF **Squirrels**

Specimen No.	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
	Pieces of lac resin	Lac larvae	Adult female insects				
			Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8
	JUNE 1954 SPECIMENS						
1	6	14	17	3	20	...	Eggs of lac insect in plenty in stomach and duodenum.
2	...	1	7	...	7	1 head of lepidopterous larva resembling *E. amabilis*.	...
3	3	...	3	1	4	...	Few eggs of lac insect in stomach.
4	3	7	...	...	...	...	...
5	Large no. (not counted)	1	72	...	72	...	Eggs of lac insect in plenty in stomach.
6	29	3	33	19	52	...	Eggs of lac insect in plenty throughout the alimentary canal.

7	37	...	97	37	134	...	Do.
8	223	1	75	34	109	2 lepidopterous larvae without heads, resembling *E. amabilis.*	Do.
9	Few (not counted)	1	28	1	29	...	Eggs of lac insect found in good no. in stomach.
10	38	5	58	1	59	1 head of lepidopterous larva resembling *H. pulverea.*	Eggs of lac insect in plenty in stomach and colon-rectum.
11	...	...	1	...	1	...	...
12	68	6	61	...	61	...	Eggs of lac insect in plenty in stomach.
13	...	...	...	...	...	...	...
14	...	...	...	...	...	...	Very few eggs of lac insect in stomach.
15	4	...	...	...	...	...	...
16	89	8	2	16	18	...	Eggs of lac insect in plenty in ileum and colon-rectum.
	JUNE 1955 SPECIMENS						
1	2	...	4	1	5	...	Few eggs of lac insect in stomach.
2	Large no. (not counted)	...	61	24	85	...	Eggs of lac insect in plenty throughout the alimentary canal.
3	15	...	16	4	20	...	Do.
4	3	...	1	...	1	...	...

TABLE I

RESULTS OF EXAMINATION OF ALIMENTARY CANAL CONTENTS OF **Squirrels**

Specimen No.	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
	Pieces of lac resin	Lac larvae	Adult female insects				
			Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8
	JUNE 1954 SPECIMENS						
1	6	14	17	3	20	...	Eggs of lac insect in plenty in stomach and duodenum.
2	...	1	7	...	7	1 head of lepidopterous larva resembling *E. amabilis*.	...
3	3	...	3	1	4	...	Few eggs of lac insect in stomach.
4	3	7	...	...	...	...	...
5	Large no. (not counted)	1	72	...	72	...	Eggs of lac insect in plenty in stomach.
6	29	3	33	19	52	...	Eggs of lac insect in plenty throughout the alimentary canal.
7	37	...	97	37	134	...	Do.
8	223	1	75	34	109	2 lepidopterous larvae without heads, resembling *E. amabilis*.	Do.
9	Few (not counted)	1	28	1	29	...	Eggs of lac insect found in good no. in stomach.
10	38	5	58	1	59	1 head of lepidopterous larva resembling *H. pulverea*.	Eggs of lac insect in plenty in stomach and colon-rectum.
11	...	...	1	...	1	...	...
12	68	6	61	...	61	...	Eggs of lac insect in plenty in stomach.
13	...	...	...	...	...	...	...
14	...	...	...	...	...	...	Very few eggs of lac insect in stomach.
15	4	...	...	...	...	...	...
16	89	8	2	16	18	...	Eggs of lac insect in plenty in ileum and colon-rectum.
	JUNE 1955 SPECIMENS						
1	2	...	4	1	5	...	Few eggs of lac insect in stomach.
2	Large no. (not counted)	...	61	24	85	...	Eggs of lac insect in plenty throughout the alimentary canal.
3	15	...	16	4	20	...	Do.
4	3	...	1	...	1	...	...

TABLE I—(*contd.*)

Specimen No.	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
	Pieces of lac resin	Lac larvae	Adult female insects				
			Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8
5	...	...	1	2	3	...	Some eggs of lac insect found in stomach.
6	13	...	45	5	50	...	Eggs of lac insect in plenty in stomach.
7	1	...	1	...	1	...	...
8	...	...	...	...	...	...	...
9	7	...	8	1	9	...	Eggs of lac insect in plenty in stomach.
10	...	...	...	...	...	...	...
	OCTOBER 1955 SPECIMENS						
1	...	...	...	...	...	...	...
2	...	...	...	...	...	...	..

3	15	...	1	1	2	1. *Eublemma* larvae ... 32 2. *Eublemma* pupae ... 3 3. *Holcocera* larvae ... 22	...
4	10	Few (not counted)	3	4	7	1. *Eublemma* larva ... 1	Good number of eggs of lac insect in stomach.
5	...	...	...	...	...	1. *Eublemma* larvae ... 2	...
6	10	...	6	1	7	...	Some eggs of the lac insects in stomach.
7	...	...	...	...	...	1. *Eublemma* larvae ... 8 2. *Holcocera* larvae ... 2	...
8	...	...	...	...	...	1. *Eublemma* larvae ... 3 2. *Holcocera* larva ... 1	...
9	...	11	...	...	...	...	...
10	...	5	...	...	...	...	...

TABLE I—(*contd.*)

Specimen No.	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
	Pieces of lac resin	Lac larvae	Adult female insects				
			Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8
5	...	...	1	2	3	...	Some eggs of lac insect found in stomach.
6	13	...	45	5	50	...	Eggs of lac insect in plenty in stomach.
7	1	...	1	...	1	...	...
8	...	...	...	...	...	...	...
9	7	...	8	1	9	...	Eggs of lac insect in plenty in stomach.
10	...	...	...	...	...	...	...
	OCTOBER 1955 SPECIMENS						
1	...	...	...	...	...	...	...
2	...	...	...	...	...	...	..
3	15	...	1	1	2	1. *Eublemma* larvae ... 32 2. *Eublemma* pupae ... 3 3. *Holcocera* larvae ... 22	...
4	10	Few (not counted)	3	4	7	1. *Eublemma* larva ... 1	Good number of eggs of lac insect in stomach.
5	...	...	...	...	...	1. *Eublemma* larvae ... 2	...
6	10	...	6	1	7	...	Some eggs of the lac insects in stomach.
7	...	...	...	...	...	1. *Eublemma* larvae ... 8 2. *Holcocera* larvae ... 2	...
8	...	...	...	...	...	1. *Eublemma* larvae ... 3 2. *Holcocera* larva ... 1	...
9	...	11	...	...	...	...	...
10	...	5	...	...	...	...	...

TABLE II

RESULTS OF EXAMINATION OF ALIMENTARY CANAL CONTENTS OF **Birds**

Specimen No.	Name of Bird	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
		Pieces of lac resin	Lac larvae	Adult female insects				
				Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8	9
	JUNE 1954 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	1	3	...	...	...	2 heads of lepidopterous larvae resembling *E. amabilis*	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	3	...	...	...	...	...
4	Do. ...	...	3	...	...	...	...	...
5	Do. ...	...	5	...	...	...	...	...
1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	...	6	...	...	...	*Holcocera* eggs—4	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	9	...	...	...	...	...

1	Redvented Bulbul (*Molpastes cafer*)	...	7	...	...	...	...	...
2	Do.	...	...	...	...	...	...	...
3	Do.	...	...	...	...	...	...	...
1	Rufousbacked Shrike (*Lanius schach*)	1	...	...	...	...	1 head of lepidopterous larva resembling *H. pulverea*	...
2	Do.	...	4	...	...	...	...	...
3	Do.	...	...	...	...	...	...	...
1	Coppersmith (*Megalaima haemacephala*)	...	2	...	...	...	...	...
2	Do.	...	11	...	...	...	...	...
1	Wood Shrike (*Tephrodornis pondicerianus*)	...	2	...	...	...	...	...
1	Jungle Babbler (*Turdoides somervillei*)	...	...	...	...	...	...	...
1	House Sparrow (*Passer domesticus*)	...	1	...	...	...	...	...
1	Indian Pitta (*Pitta brachyura*)	...	...	...	...	...	...	..
1	King Crow (*Dicrurus macrocercus*)	...	2	...	...	...	...	...
	JUNE 1955 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*)	...	...	...	...	...	...	...

TABLE II

Results of examination of Alimentary Canal contents of Birds

Specimen No.	Name of Bird	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
		Pieces of lac resin	Lac larvae	Adult female insects				
				Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8	9
	JUNE 1954 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	1	3	...	...	...	2 heads of lepidopterous larvae resembling *E. amabilis*	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	3	...	...	...	...	...
4	Do. ...	...	3	...	...	...	...	...
5	Do. ...	...	5	...	...	...	...	...
1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	...	6	...	...	...	*Holcocera* eggs—4	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	9	...	...	...	...	...
1	Redvented Bulbul (*Molpastes cafer*) ..	...	7	...	...	...	...	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	...	...	...	...	...	...
1	Rufousbacked Shrike (*Lanius schach*) ...	1	...	...	...	...	1 head of lepidopterous larva resembling *H. pulverea*	...
2	Do. ...	...	4	...	...	...	...	...
3	Do. ...	...	...	...	...	...	...	...
1	Coppersmith (*Megalaima haemacephala*) ...	...	2	...	...	...	...	...
2	Do. ...	...	11	...	...	...	...	...
1	Wood Shrike (*Tephrodornis pondicerianus*) ...	...	2	...	...	...	...	...
1	Jungle Babbler (*Turdoides somervillei*) ...	...	...	...	...	...	...	...
1	House Sparrow (*Passer domesticus*) ...	...	1	...	...	...	...	...
1	Indian Pitta (*Pitta brachyura*) ...	...	...	...	...	...	...	...
1	King Crow (*Dicrurus macrocercus*) ...	...	2	...	...	...	...	...
	JUNE 1955 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	...	...	...	...	...	...	...

TABLE II—(*contd.*)

Specimen No.	Name of Bird	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
		Pieces of lac resin	Lac larvae	Adult female insects				
				Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8	9
	JUNE 1955 SPECIMENS—(*contd.*)							
2	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	...	...	...	...	...	...	...
3	Do. ...	...	...	...	...	...	...	...
4	Do. ...	...	...	...	...	...	...	...
1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	...	2	1	3	4	...	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	6	...	...	...	...	...
4	Do. ...	...	...	...	...	...	...	...
5	Do. ...	Few (not counted)	18	5	3	8	...	...

1	Redvented Bulbul (*Molpastes cafer*) ...	...	...	...	...	...	...	...	...
1	Rufousbacked Shrike (*Lanius schach*) ...	...	3	...	...	...	...	...	...
2	Do. ...	...	1	..	...	...	...	...	...
3	Do. ...	...	5	...	...	...	...	...	...
1	House Sparrow (*Passer domesticus*) ...	...	...	..	...	...	...	...	...
2	Do. ...	...	..	...	...	...	...	...	...
3	Do. ...	...	...	...	...	...	...	...	...
1	King Crow (*Dicrurus macrocercus*) ...	...	1	...	...	...	...	...	...
2	Do. ...	...	1	...	...	...	...	...	...
1	Common Iora (*Aegithina tiphia*) ...	...	...	...	...	...	...	...	...
1	Common Weaver Bird (*Ploceus philippinus*) ...	...	...	...	...	...	...	...	...
1	Crow Pheasant (*Centropus sinensis*) ...	...	...	...	...	...	...	...	...
1	Golden Oriole (*Oriolus oriolus*) ...	...	...	...	...	.	...	...	...
1	Common Myna (*Acridotheres tristis*) ...	...	...	...	...	...	...	...	...
2	Do. ...	...	...	...	...	...	...	...	...

TABLE II—(*contd.*)

Specimen No.	Name of Bird	Stomach contents pertaining to lac: Pieces of lac resin	Lac larvae	Adult female insects: Entire or almost entire	In fragments	Total	Other insect species associated with lac	Remarks
1	2	3	4	5	6	7	8	9
	JUNE 1955 SPECIMENS—(*contd.*)							
2	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	...	...	...	...	..	..	...
3	Do. ...	...	...	...	...	...	...	..
4	Do. ...	...	...	...	...	..	...	...
1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	...	2	1	3	4	...	...
2	Do. ...	...	...	...	...	...	...	...
3	Do. ...	...	6	...	...	...	...	...
4	Do. ...	...	...	...	...	...	...	...
5	Do. ...	Few (not counted)	18	5	3	8	...	..
1	Redvented Bulbul (*Molpastes cafer*) ...	...	.		..	.	...	...
1	Rufousbacked Shrike (*Lanius schach*) ...	...	3	...	...	...	...	...
2	Do. ...	...	1	.	...	..	...	...
3	Do. ...	...	5	...	...	.	...	...
1	House Sparrow (*Passer domesticus*) ...	...	...	.	..	..	...	...
2	Do. ...	...	..	...	...	...	...	...
3	Do. ...	...	...	...	...	...	...	..
1	King Crow (*Dicrurus macrocercus*) ...	...	1	...	..	...	...	..
2	Do. ...	...	1	..	...	...	...	...
1	Common Iora (*Aegithina tiphia*) ...	...	...	...	...	...	...	...
1	Common Weaver Bird (*Ploceus philippinus*) ...	...	...	...	...	...	...	...
1	Crow - Pheasant (*Centropus sinensis*) ...	.	...	...	...	...	...	..
1	Golden Oriole (*Oriolus oriolus*) ...	...	...	...	...	..	.	...
1	Common Myna (*Acridotheres tristis*) ...	...	...	...	...	...	...	...
2	Do. ...	...	...	...	...	...	...	...

TABLE II—(*contd.*)

Specimen No.	Name of Bird	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
		Pieces of lac resin	Lac larvae	Adult female insects				
				Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8	9
	JUNE 1955 SPECIMENS—(*contd.*)							
1	Small Minivet (*Pericrocotus peregrinus*) ...	...	...	...	...	...	...	...
2	Do. ...	...	3	...	...	...	...	...
3	Do. ...	...	2	...	...	...	...	...
4	Do. ...	...	3	...	...	...	...	...
5	Do. ...	...	...	...	...	...	...	...
6	Do. ...	...	...	...	...	...	...	...
	OCTOBER 1955 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	31	3	3	19	22	*Eublemma* larvae ... 2	...
2	Do. ...	(Few; not counted)	...	...	...	...	*Eublemma* larvae... 32 *Eublemma* pupae ... 12 *Eublemma* adult ... 1 *Elasmus* pupae .. 3	...

1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	31	157	2	9	11	...	...
2	Do. ...	6	13	...	1	1	...	...
1	Redvented Bulbul (*Molpastes cafer*) ...	18	...	3	2	5	...	...
1	Coppersmith (*Megalaima haemacephala*) ...	...	...	...	...	...	...	...
1	Common Iora (*Aegithina tiphia*) ...	...	...	...	...	...	...	...

TABLE II—(*contd.*)

Specimen No.	Name of Bird	Stomach contents pertaining to lac					Other insect species associated with lac	Remarks
		Pieces of lac resin	Lac larvae	Adult female insects				
				Entire or almost entire	In fragments	Total		
1	2	3	4	5	6	7	8	9
	JUNE 1955 SPECIMENS—(*contd.*)							
1	Small Minivet (*Pericrocotus peregrinus*) ...	..	...	...	...	..	...	.
2	Do. ...	...	3	...	...	...	..	..
3	Do. ...	...	2	...	...	...	...	...
4	Do. ...	...	3	...	...	...	...	...
5	Do. ...	...	...	...	...	...	...	..
6	Do. ...	...	...	...	...	...	..	...
	OCTOBER 1955 SPECIMENS							
1	Mahratta Woodpecker (*Dryobates mahrattensis*) ...	31	3	3	19	22	*Eublemma* larvae ... 2	...
2	Do. ...	(Few; not counted)	...	..	...	...	*Eublemma* larvae... 32 *Eublemma* pupae ... 12 *Eublemma* adult ... 1 *Elasmus* pupae .. 3	...
1	Goldenbacked Woodpecker (*Brachypternus benghalensis*)	31	157	2	9	11	...	...
2	Do. ...	6	13	...	1	1	...	...
1	Redvented Bulbul (*Molpastes cafer*) ...	18	...	3	2	5	...	...
1	Coppersmith (*Megalaima haemacephala*) ...	...	...	...	...	...	...	...
1	Common Iora (*Aegithina tiphia*) ...	...	...	...	...	...	...	...

TABLE III

Extent of damage by Squirrels and Birds assessed on the basis of Lac-bearing Twigs

Season	Total no. of twigs harvested	Percentage of twigs with cells						Percentage damaged out of total number of twigs having living cells
		All dead	Living and not damaged	Less than 10% damaged	Between 10 to 25% damaged	Between 25 to 50% damaged	Over 50% damaged	
(a) *On 25 trees with better survival of lac cells*								
1955 Summer ...	2,079	15·4	36·1	20·4	7·1	4·3	16·6	57·2
1956 Summer ...	2,052	18·5	54·6	14·4	3·6	2·5	7·2	34·0
(b) *On 25 trees with poor survival of lac cells*								
1955 Summer...	1,236	49·4	39·7	5·1	1·2	1·4	3·2	21·6
1956 Summer...	1,104	30·5	56·3	8·3	1·0	1·2	2·8	18·9
(c) *On all 50 trees taken together as representing the entire area*								
1955 Summer...	3,315	28·1	37·5	14·4	5·0	3·2	11·6	47·8
1956 Summer...	3,156	22·7	54·7	12·3	2·3	2·0	5·6	29·3

TABLE IV

EXTENT OF DAMAGE BY SQUIRRELS AND BIRDS ASSESSED ON THE BASIS OF LAC CELLS

Season	Total length of twigs	Total no. of cells examined	Percentage of dead cells	Percentage of living cells including damaged ones	Percentage damaged among living cells	No. of cells per inch surviving heat and damage
(a) *On* 75 *twigs from* 25 *trees with better survival of lac cells*						
1955 Summer ...	116′–10″	15,332	64·1	35·9	61·9	1·5
1956 Summer ...	127′–9″	12,501	37·5	62·5	40·6	3·0
(b) *On* 75 *twigs from* 25 *trees with poorer survival of lac cells*						
1955 Summer ...	92′–8″	13,860	89·6	10·4	44·8	0·7
1956 Summer ...	100′–7″	16,929	73·0	27	19·4	3·0
(c) *On all* 150 *twigs from the* 50 *trees taken together as representing the entire area*						
1955 Summer ...	209′–6″	29,192	76·1	23·9	58·4	1·2
1956 Summer ...	228′–4″	29,430	57·9	42·1	32·8	3·0

THE ALGAL FLORA OF THE PONDS AND PUDDLES INSIDE THE BANARAS HINDU UNIVERSITY GROUNDS, INDIA[1]

BY

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(*With 17 text-figures*)

The present communication deals with a systematic enumeration of various algae collected from the ponds and puddles inside the University grounds, during the investigation of the algal periodicity with reference to the climatic and chemical factors.

In all, 61 forms representing 38 genera have been described of which five varieties and seven forms are new.

1. **Carteria cordiformis** (Carter) Dill. Pascher, Süsswasserfl. Deutsch. Öster. Schweiz 4 : 149, f. 97, 1927.

Breadth of the cell, 7.2-14.4 μ.
Length of the cell, 10.8-16·2 μ.

Habit : Free-floating.

2. **Pandorina morum** (Muller) Bory. Prescott. Algae West. Great Lakes Area, p. 75, t. 1, f. 23, 1951.

Breadth of the colony, 36-50 μ.
Breadth of the cell, 12-15 μ.
Length of the cell, 8-12.8 μ.

Habit : Free-floating.

3. **Volvox aureus** Ehr. Prescott. Algae West. Great Lakes Area, p. 78, t. 2, f. 4, 1951.

Colony free-swimming, spherical or ovate, composed of from 500 to many small cells arranged in the peripheri of the mucilage.

Diameter of the cells, 4.5-5.4 μ.

Habit : Planktonic.

4. **Characium ambiguum** Hermann. Pascher, Süsswasserfl. Deutsch. 5 : 79, f. 17, 1915.

Cells solitary, lens shaped, fusiform, narrowed to sharp point anteriorly, tapering posteriorly to a fine hair-like stipe, without any attaching disc.

Breadth of the cell, 3.6-4.5 μ.
Length of the cell, 18 μ.

Habit : Epiphytic on *Oedogonium* sp.

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5. **Chlorella vulgaris** Beyerinck. Pascher, 5 : 111, f. 71, 1915.

Cells spherical. It forms freshwater sponge either free-floating or attached to submerged aquatic angiosperms.

Diameter of the cells, 3.6-8.1 μ.

Habit : In the freshwater sponge

6. **Kirchneriella obesa** (W. West) Schmidle. Pascher 5 : 181, f. 267, 1915; Prescott, Algae West. Great Lakes Area, p. 259, t. 58, f. 5, 1951.

Breadth of the cell, 4.5-7.2 μ.
Length of the cell, 9.9-16.2 μ.

Habit : Mucilaginous patches floating in water.

7. **Pediastrum tetras** (Ehr.) Ralfs. Brunnthaler & Pascher, Süsswasserfl. Deutsch. 5 ; 103, f. 64a, 1915.

A colony consists commonly of 4-8 cells ; inner cell with six straight sides but with one margin deeply incised ; peripheral cells crenate with a deep incision in the free outer margin.

Breadth of the cell, 10.8-12.6 μ.
Length of the cell, 12 μ.

Habit : Planktonic.

8. **Hydrodictyon reticulatum** (L.) Lagerheim. Brunnthaler & Pascher, Süsswasserfl. 5 : 107, f. 68, 1915.

Breadth of the cell, 80-176 μ.
Length of the cell, 640-1,120 μ.

Habit : Free-floating.

9. **Scenedesmus bijugatus** (Turpin) Kütz. Brunnthaler & Pascher, Süsswasserfl. 5 : 167, 1915.

Colony four-celled in a single series ; obtusely rounded at both ends ; cell wall smooth.

Breadth of the cell, 2.7-3.6 μ.
Length of the cell, 7.2-11.7 μ.

Habit : Planktonic.

10. **Uronema confervicolum** Lagerheim. Heering, Pascher, Süsswasserfl. 6 : 36, f. 37, 1914.

Breadth of the cell, 5.4- 7.2 μ.
Length of the cell, 7.2-10.8 μ.

Habit : Epiphytic on *Oedogonium* sp. along with *Aphanochaete repens.*

11. **Cladophora glomerata** (L.) Kutz. Heering, Pascher, Süsswasserfl. 7 : 35. ff. 14, 15 and 39, 1921 ; Prescott, Algae West. Great Lakes Area, p. 138, t. 20, ff. 8 and 9, 1951.

Breadth of the cell (main axis), 28.8 μ.
Length of the cell (main axis), 234-360 μ.
Breadth of the cell (branches), 14.4-28.8 μ.
Length of the cell (branches), 115.2-234.0 μ.

Habit : Epiphytic on the shells of snails.

12. **Chaetophora pisiformis** (Roth) Ag. Heering, Pascher, Süsswasserfl. 6 : 96, 1914.

Breadth of the cell, 6.3-7.2 μ.
Length of the cell, 14.4-32.4 μ.

Habit : Green balls attached to the submerged leaves.

13. **Stigeoclonium nanum** Kutz. Heering, Pascher, Süsswasserfl. 6: 74, f. 97, 1914.

Breadth of the cell (prostrate system), 10.8 μ.
Length of the cell (prostrate system), 10.8 μ.
Breadth of the cell (erect system), 3.6-5.4 μ.
Length of the cell (erect system), 3.6-10.8 μ.

Habit : Epiphytic on aquatic angiosperms.

14. **Stigeoclonium attenuatum** Hazen in *Mem. Torr. Bot. Club.* 11 : 170, 1902.

Dark green ; branches attenuating, tapering into a fine point ; branches alternate.

Branches of the cell, 5.4-7.2 μ.
Length of the cell, 6.3 8.1 μ.

Habit : Epiphytic on aquatic angiosperms.

15. **Stigeoclonium flagelliferum** Kütz. Heering, Pascher, Süsswasserfl. 6 : 81, ff 118, 119 and 121, 1914.

Breadth of the main filament, 12.6-18.0 μ.
Length of the cell, 21.6-32.4 μ.
Breadth of the branches, 7-10.8 μ.
Length of the cell, 7.2-19.2 μ.

Habit: Epiphytic on aquatic plants.

16. **Aphanochaete repens** A. Braun. Heering, Pascher, Süsswasserfl. 6 : 128, 1914 ; Prescott, Algae West. Great Lakes Area, p. 125, 1951.

Breadth of the cell, 7.2-10.8 μ.
Breadth of the seta at the base, 3 μ.

Habit : Epiphytic on *Oedogonium* sp., and *Zygnema sphaerica* forma *microspora* form. nov.

17. **Coleochaete scutata** Breb. Heering, Pascher, Süsswasserfl. 6: 135, f. 194, 1914.

Breadth of the cell, 15-30 μ.
Length of the cell, 6-42 μ.
Breadth of the oospore, 95 μ.

Habit : Epiphytic on *Ipomoea* sp.

18. **Oedogonium lautumnarium** Wittrock. Tiffany, The Oedogoniaceae, p. 72, t. XIV, ff. 132, 133, 1930.

Forma. (text-fig. 12).

Breadth of the cell, 9-14.4 μ.
Length of the cell, 43.2-61.2 μ.
Breadth of the oogonium, 32.4 μ.
Length of the oogonium, 39.6-41i4 μ.
Breadth of the oospore, 30.6 μ.
Length of the oospore, 32.4 μ.
Breadth of the antheridia, 9-14.4 μ.
Length of the antheridia, 9.7-10.8 μ.

The present form differs from the type in narrower filaments, smaller oogonia and oospores, and slightly bigger antheridia. It differs from forma *tenuis* Singh, in narrower vegatative filaments and in having larger oogonia and bigger antheridia.

Habit : Free-floating.

[Forma praesens a forma typica differt filamentis angustioribus, oogoniis et oosporis, minoribus antheridiis paulo maioribus. Differt quoque a forma *tenui* Singh filamentis vegetativis angustioribus, oogoniis maioribus antheridiis amplioribus. Habitus : Natans, libera.]

19. **Oedogonium rufescens** Wittrock. Hirn, Monog. Oedogon. p. 76, 1900 ; Tiffany, The Oedogoniaceae, p. 66, 1930.

Forma **tenuis** form. nov. (text-fig. 13).

Dioecious, macrandrous, oogonia intercalary in pairs, obovoid or depressed-obovoid-globose ; pore median ; oosepore globose nearly filling the oogonium ; spore wall smooth.

Breadth of the cell, 6.3-7.2 μ.
Length of the cell, 28.8-32.4 μ.
Breadth of the oogonium, 18-21.8 μ.
Length of the oogonium, 18-2.18 μ.
Breadth of the oospore, 16.2-† μ,
Length of the oospore, 14.4-18 μ.

[Dioica, macrandra, oogoniis intercalaribus binatis, obovoidea vel depresso-obovoideo-globosa ; porus medius ; oospora globosa oogonium fere implens ; sporae parietes leves.]

This form differs from the type in smaller and narrower filaments and smaller oogonia and oospores. It differs from f. *elongatum* Hirn. in narrower filaments and smaller oogonia. It differs from f. *exiguum* (Elfv.) Hirn. also in smaller oogonia.

Habit: Epiphytic on *Ipomea* sp. along with *Coleochaete scutata.*

[Forma haec a typica differt filamentis angustioribus, oogoniis et oosporis minoribus ; differt a forma *elongatum* Hirn. filamentis angustioribus, oogoniis minoribus ; differt quoque a f. *exiguum* Hirn. oogoniis minoribus.

Typus lectus epiphyticus *Ipomoeae* sp. simul cum *Coleochaete scutata.*]

20. **Oedogonium hians** Nordstedt & Hirn. Hirn, Monog. Oedog. 227, t. 38, f. 233, 1900.

Breadth of the cell, 25.2-36 μ.
Length of the cell, 86.4-90 μ.
Breadth of the oogonium, 61.2-63 μ.
Length of the oogonium, 72-79.2 μ.
Breadth of the antheridia, 9 μ.
Length of the antherdia, 7·2 μ.
Breadth of the nannandria, 18 μ.
Length of the nannandria, 18-25.2 μ.

Habit: Free-floating.

21. **Bulbochaete** sp.

Dioecious ; oogonia placed just below a seta.

Breadth of the cell, 18-21.6 μ.
Length of the cell, 16.2-19.8 μ.
Breadth of the oogonium, 28.8 μ.
Length of the 'oogonium, 36-37.8 μ.

Since no mature oospores and pores were observed, the identification of the species was rendered impossible.

Habit: Epiphytic on *Aulosira fritschii* and *Oedogonium* sp.

22. **Spirogyra anomala** Rao. Rao in *J. Indian Bot. Soc.* 16: 284, ff. D & E, 1937.

Breadth of the cell, 97.2-129.8 μ.
Length of the cell, 90-130 μ.
Breadth of the zygospore, 75.6 μ.
Length of the zygospore, 118.0-126 8 μ.
Breadth of the fructifying cell, 108 μ.

Habit: Free-floating along with *Spirogyra nitida* var. *microspora* var. nov.

23. **Spirogyra nitida** (Dillwyn) Link. var. **microspora** var. nov.

Vegetative cells 2–3 times as long as broad; end walls plane; branched and unbranched lateral rhizoids; conjugation scalariform; conjugation canal formed by both gametangia; fructifying cells not swollen; zygospores ellipsoid, pointed at the ends; formed in one of the gametangia; exospore smooth, mesospore thick, yellowish brown (text-fig. 14, 15).

Breadth of the cell, 57.6-72 μ.
Length of the cell, 133.2-162 μ.
Breadth of the zygospore, 56.6 μ.
Length of the zygospore, 90 μ.
Breadth of the fructifying cells, 72 μ.

This form differs from the type in smaller zygospores and in having branched and unbranched lateral rhizoids.

Habit: Free-floating.

[Varietas haec a typo recedit zygosporis minoribus atque praesentia rhizoidum lateralium ramosorum vel simplicium.]

24. **Spirogyra margaritata** Wollny. Pascher, Süsswasserfl. 9: 29, f. 35, 1913.

Forma **kurze** form. nov.

Vegetative cells cylindrical; end walls plane; chloroplasts 4–6; conjugation scalariform; fructifying cells unswollen; zygospores spherical.

Breadth of the cell, 108-116 μ.
Length of the cell, 100.8-194.4 μ.
Breadth of the zygospores, 61.2-75.6 μ.

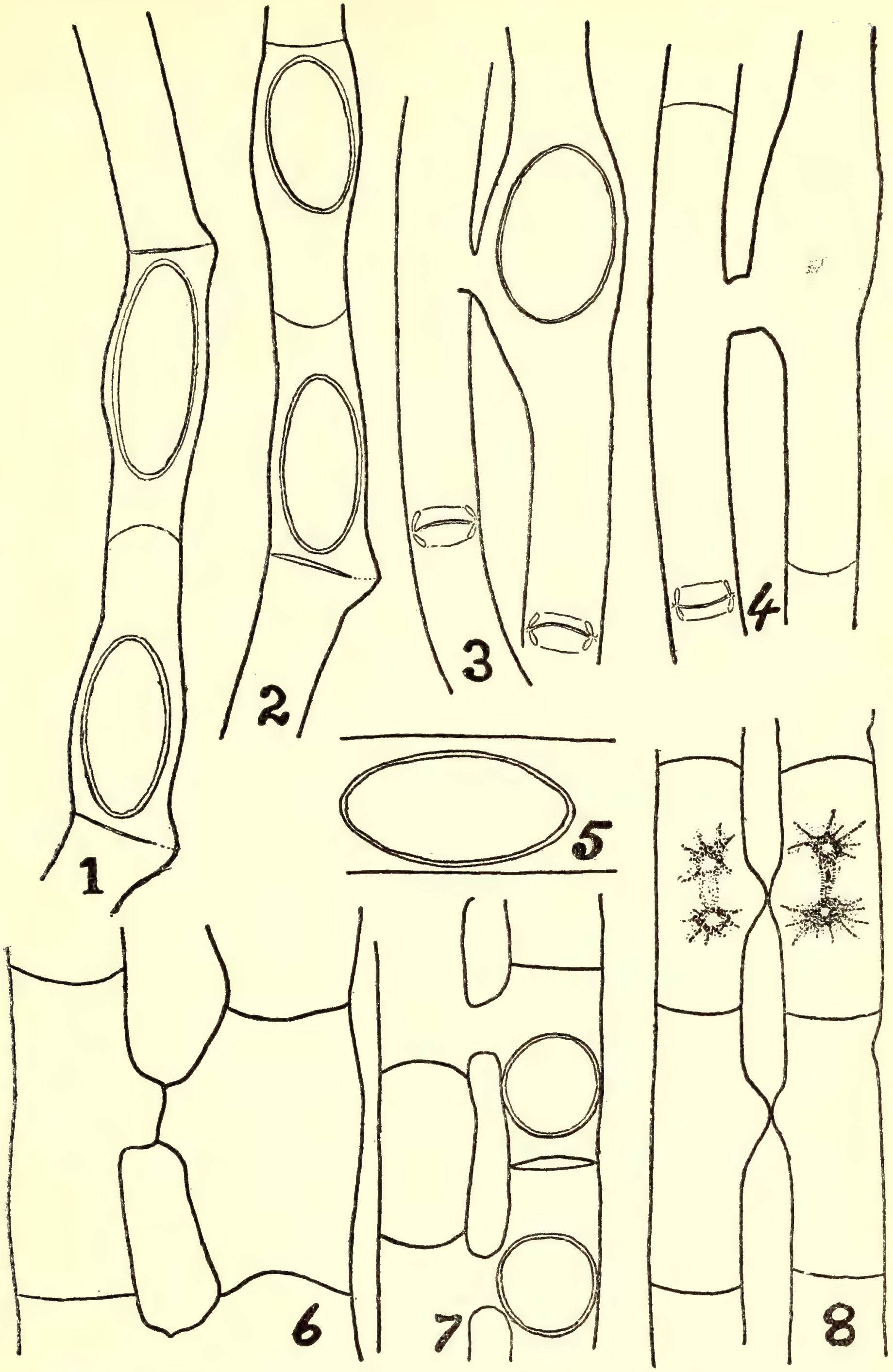
This form differs from the type in having fewer chloroplasts and broader cells. It differs from var. *microspora* Singh in the number of chloroplasts in the broader and shorter cells and bigger zygospores.

Habit: Free-floating.

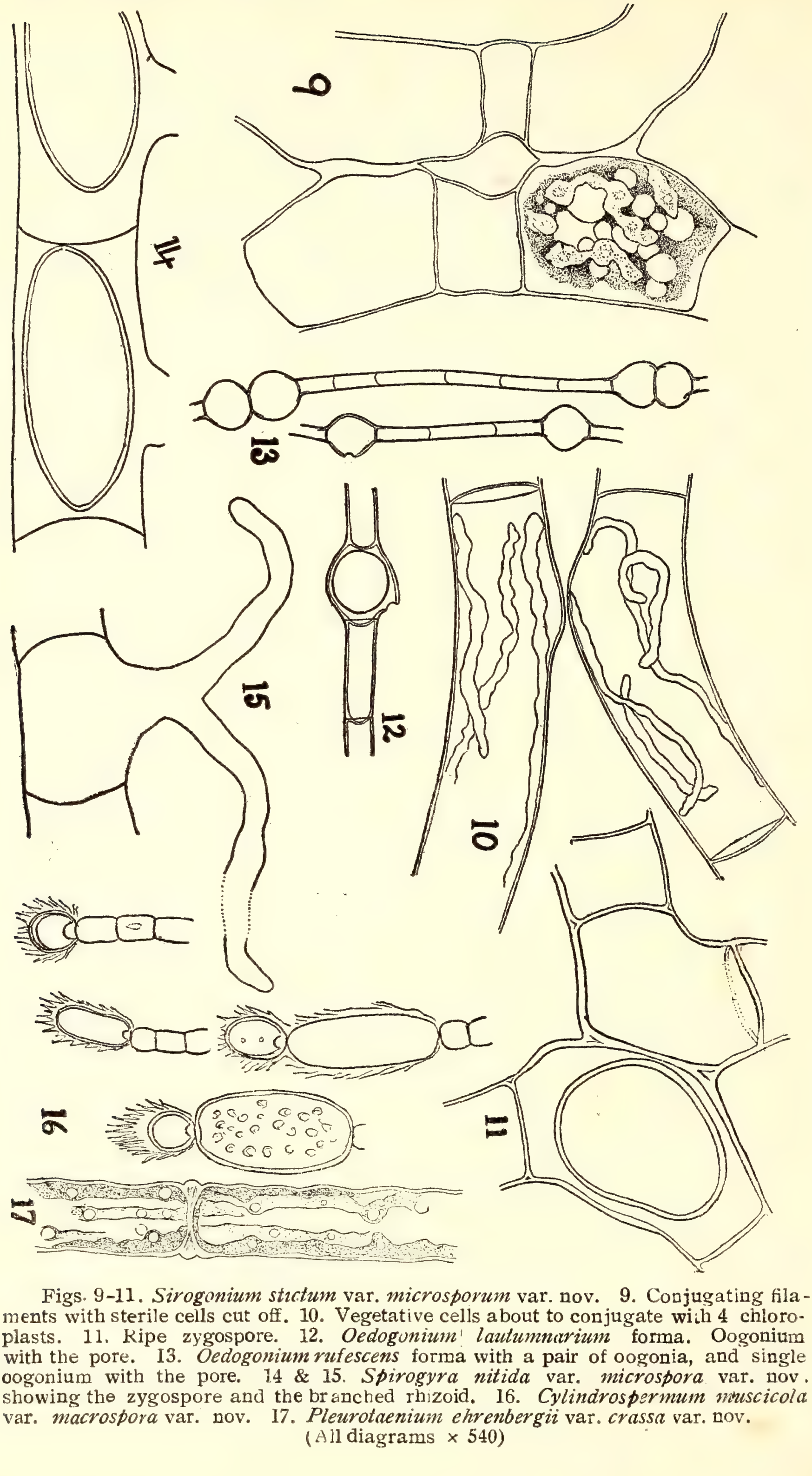
[Differt a typo chloroplastis paucioribus, cellulis latioribus; a var. *microspora* Singh numero chloroplastorum, cellulis latioribus et brevioribus atque zygosporis maioribus.]

25. **Spirogyra spreeiana** Rabenhorst var. **kashiensis** var. nov.

Vegetative cells 4–8 times as long as broad; end walls replicate; chloroplast one; conjugation lateral and scalariform conjugation very



Figs. 1–4. *Spirogyra spreeiana* var. *kashiensis* var. nov. 1 & 2. Lateral conjugation and the zygospores. 3 & 4. Scalariform conjugation. 5 & 6. *Spirogyra singularis* forma. 7 & 8. *Zygnema sphaerica* var. *microspora* var. nov. 8. Early stage of conjugation with the conjugation canal as small bulgings. 7. Ripe zygospores.
(All diagrams × 540)



Figs. 9-11. *Sirogonium stictum* var. *microsporum* var. nov. 9. Conjugating filaments with sterile cells cut off. 10. Vegetative cells about to conjugate with 4 chloroplasts. 11. Ripe zygospore. 12. *Oedogonium lautumnarium* forma. Oogonium with the pore. 13. *Oedogonium rufescens* forma with a pair of oogonia, and single oogonium with the pore. 14 & 15. *Spirogyra nitida* var. *microspora* var. nov. showing the zygospore and the branched rhizoid. 16. *Cylindrospermum muscicola* var. *macrospora* var. nov. 17. *Pleurotaenium ehrenbergii* var. *crassa* var. nov.
(All diagrams × 540)

rare; fructifying cells swollen; zygospores ellipsoidal; exospore thin, smooth and hyaline; mesospore thick, smooth and yellowish brown; endospore indistinct (text-figs. 1-4).

Breadth of the cells, 18-21.6 μ
Length of the cells, 61.2-136.8 (-231.8) μ.
Breadth of the zygospore, 25.2-32.4 μ.
Length of the zygospore, 50.4-54 μ.
Breadth of the fructifying cell, 18-39·6 μ.

The present form differs from the type in the conjugation being lateral and scalariform very rare. It differs from var. *crassa* Rao in smaller meaurements of the cells and spores, and from var. *kashmirensis* Misra in bigger cells. After the lateral conjugation, the conjugation canal completely disappears simulating the appearance of aplanospores in the cells. That these are formed by conjugation is evidenced by the fact that the alternating cells are empty.

Habit: Free-floating.

[A typo differt conjugatione laterali et scalariformi rarissima a var. *crassa* Rao magnitudine minori cellularum et sporarum et a var. *kashmirensis* Misra cellulis maioribus. Post conjugationem lateralem, conjugationis canalis penitus offuscatur, simulatis aplanosporis in eellulis. Cellulae alternae vacuae monstrant aplanosporas formatas esse conjugatione. Habitus : libera natans.]

26. **Spirogyra singularis** Nordstedt. Jao in *Sinensia*, 6: 592, t. 5, f. 62, 1933.

Forma **ventricosa** form nov.

Vegetative cells 4-6 times as long as broad; end walls plane; single chloroplast making 5 turns; scalariform conjugation; fertile cells ventricose; zygospores ellipsoid (text-figs. 5 and 6).

Breadth of the cell, 36 μ.
Length of the cell, 72 μ.
Breadth of the zygospore, 28·8-39,6 μ.
Length of the zygospore, 50·4-72 μ.

This form differs from the type in having ventricose fructifying cells.

Habit: Free-floating.

27. **Zygnema sphaerica** Misra in *Proc. Ind. Acad. Sci.* 5: 111 f. 1c, 1937.

Forma **microspora** form nov.

Conjugation scariform; zygospore in the gametangia; fructifying cells unswollen; zygospores spherical; mesospore smooth (text-figs. 7 and 8).

Breadth of the cell, 27·0-32·4 μ.
Length of the cell, 43·2-62 μ.
Breadth of the zygospore, 27-28·8 μ.

It differs from the type in much broader and longer cells and slightly smaller zygospores. It differs from f. *megaspora* Rao in smaller zygospores.

Habit: Free-floating.

[Differt a typo cellulis multo latioribus et longioribus atque zygosporis paulo minoribus. A f. *megaspora* Rao differt zygosporis minoribus.]

28. **Sirogonium stictum** Kutz. var. **microsporum** var. nov.

End walls plane; chloroplasts 4; straight; fructifying cells swollen; zygospore ellipsoid, ends rounded; mesospore smooth, endospore indistinct (text-figs. 9–11).

Breadth of the cell, 45-55·8 μ.
Length of the cell, 126-270 μ.
Breadth of the zygospore, 64·8 μ.
Length of the zygospore, 93·6-108 μ

This form differs from the type in broader cells and broader zygospores, and in the fertile cells being inflated from 72-82.8 μ. In *S. stictum* var. *megasporum* Jao the zygospore is not less than 70 μ broad while in the present form it is not more than 64.8 μ broad. It also differs from *S. floridanum* in smaller cells and zygospores.

Habit: Free-floating.

[A typo differt cellulis zygosporis latioribus atque cellulis fertilibus tumescentibus 72-82.8 μ. In *S. stricto* var. *megasporo* Jao zygospora plus 70 μ lata eat, in praesenti vero forma tantum usque ad 64.8 μ lata. Differt quoque a *S. floridano* cellulis minoribus et zygosporis.]

Habitus: natans libera.

29. **Penium libulata** (Forke) Nordst. West & West, A Monograph of the British Desmidiaceae, 1: 73, t. 7, ff. 6 & 7, 1904.

Breadth of the cell, 50.4 μ.
Length of the cell, 302·4 μ.

Habit: Planktonic.

30. **Closterium acerosum** (Schrank) Ehr. West & West, A Monograph of the British Desmidiaceae, 1: 146, t. 18, ff. 2-5, 1904.

Breadth of the cell, 37·8 μ.
Length of the cell, 417·6 μ.

Habit: Planktonic.

31. **Closterium cornu** Ehr. West & West, A Monograph of the British Desmidiaceae, 1: 157, t. 20 ff. 1-5, 1904.

Breadth of the cells, 10·8 μ.
Length of the cells, 133·2 μ.

Habit: Planktonic.

32. **Closterium decorum** Breb. West & West, A Monograph of the British Desmidiaceae, 1: 167, t. 17, ff. 7 & 8, t. 28, ff. 1-3, 1904.

Breadth of the cell, 28·8 μ.
Length of the cell, 447·2 μ.
Breadth at the apices, 9 μ.

Habit: Planktonic.

33. **Closterium lineatum** Ehr. West & West, Alg. S. England, 169, t. 24, ff. 1–5, 1897.

Breadth of the cell, 23·8 μ.
Length of the cell, 216 μ.
Breadth at the apices, 8·1 μ.

34. **Closterium ehrenbergii** Mengh. West & West, A Monograph of the British Desmidiaceae, 1: 143, t. 17, ff. 1-4 1904.

Forma **tenuis** form. nov.

Cells eight times longer than broad; curved as a well-defined arc; inner margin concave but slightly inflated in the median portion; pyrenoids scattered; chloroplasts with 4-6 ridges.

Breadth of the cell, 16·2 μ.
Length of the cell, 129·6 μ.
Breadth at the apices, 5·4 μ.

This form differs from the type in smaller cells and in having fewer ridges (4-6), while in the type 8-10.

Habit: Planktonic.

35. **Closterium pusillum** Hantz. West & West, A Monograph of the British Desmidiaceae, 1: 162, 1904.

Forma.

Cells very small; nearly six times longer than broad; slightly curved; ventral margin almost straight and slightly tumid; cell wall smooth colourless; chloroplasts ridged with 2-3 pyrenoids.

Breadth of the cell, 19·8 μ.
Length of the cell, 104·4 μ.

It differs from the type in bigger cells with slightly tumid ventral margin. It also differs from var. *monolithum* and var. *major* in bigger cells.

Habit: Planktonic.

36. **Pleurotaenium ehrenbergii** (Breb.) De Bary var. **crassa** var. nov.

Cells nearly twelve times longer than broad; semicell with a distinct basal inflation and undulation above it. Apices bordered by a ring of rounded tubular, 7-9 tubules are visible; cell wall punctate.

Breadth of the cell, 50·4–54 μ.
Length of the cell, 640·8 μ.

It differs from the type in bigger cells and in a prominent basal bulging and undulation throughout. It also differs from var. *undulatum* in broader cells.

Habit: Planktonic.

[A typo differt cellulis maioribus atque undulatione basali tumescenti. Cellulis latioribus a var. *undulata* differt.]

Habitus: Planktonicus.

37. **Cosmarium nitidulum** De Not. West & West, A Monograph of the British Desmidiaceae, 2: 197, 1905.

Breadth of the cell, 18–18·9 μ.
Length of the cell, 25·2 μ.
Breadth at the isthmus, 9 μ.

This form differs from the type in smaller cells.

Habit: Planktonic.

38. **Cosmarium depressum** (Nag.) Lund. West & West, A Monograph of the British Desmidiaceae, 2: 176, t. 62, ff. 2-5, 1905.

Breadth of the cell, 28·8 μ.
Length of the cell, 27 μ.
Breadth at the isthmus, 8·1 μ.

Habit: Planktonic.

39. **Micrasterias americana** (Ehr.) Ralfs. West & West, A Monograph of the British Desmidiaceae, 2 : 117, t. 53, ff. 4, 5, 1905.

Breadth of the cell, 108-144 μ.
Length of the cell, 144-180 μ.
Breadth at the isthmus, 18-21·6 μ.

Habit : Planktonic.

40. **Staurastrum clepsydra** Nordst. var. **sibericum** (Borge). West & West, Further contrib. Freshw. Plankton Scott. Lochs, 502, t. 7, f. 20, 1905.

Breadth of the cell, 18 μ.
Length of the cell, 21.6, μ.

Habit : Planktonic.

41. **Staurastrum dubium** West. West & Carter, A Monograph of the British Desmidiaceae, 112, t. 146, f. 4, 1923.

Breadth of the cell, 60.4 μ
Length of the cell, 32.4 μ.
Breadth at the apices, 9.9 μ.

Habit : Planktonic.

42. **Staurastrum dickie** Ralfs. West & West, A Monograph of the British Desmidiaceae, 5 : 3, t. 129. ff. 14 & 15, 1923.

Breadth of the cell, 28.8 μ.
Length of the cell, 23.4 μ.
Breadth at the isthmus, 7.2 μ.

Habit : Planktonic.

43. **Vaucheria geminata** (Vauch) De Candolle. Heering, Paschers, Süsswasserfl. 7 : 89, f. 79, 1921.

Breadth of the cell, 36-43.2 μ.
Length of the cell, 19.6-21.6 μ.
Breadth of the oogonia, 43.8-57.6 (— 64.8) μ.

Habit : Terrestrial in the dried pond mud.

45. **Botrydium tuberosum** Iyeng. Iyengar in *J. Indian Bot. Soc.* 195, t. 1, ff. 1-5, 1925.

Breadth of the vesicle, 200-310 μ.

Habit : On moist soil.

46. **Botrydium granulatum** (L.) Grev. Smith, Freshwater Algae of the United States, 401, f. 314 A, 1950.

Breadth of the vesicle, 150-200 μ.

Habit : On moist soil.

47. **Euglena viridis** Ehr. Fritsch, Structure and Reproduction of Algae, 1 : 726, f. 239 G, 1935

Length of the cell, 57.6-144 μ.

Habit : Free-floating.

48. **Merismopedia punctata** Meyen. Geitler, Rabenhorst, Kryptogammenflora, 14 : 263, 1930–32.

Breadth of the colony, 56-72 μ.
Length of the colony, 80-95 μ.
Breadth of the cell, 2.6-3.6 μ.

Habit : Planktonic as well as in the bottom mud.

49. **Spirulina gomontii** Grev. Geitler, Rabenhorst, Kryptogammenflora, 14 : 930, 1930–32.

Breadth of the trichome, 3.6 μ.
Distance between the spirals, 3-3.6 μ.

Habit : On the bottom mud.

50. **Oscillatoria granulata** Gardner. Geitler, Rabenhorst, Kryptogammenflora, 14 : 963, 1930–32.

Breadth of the cell, 2.7-4.5 μ.

Habit : On the bottom mud.

51. **Oscillatoria lacustris** (Kleb) Geitler, in Rabenhorst, Kryptogammenflora, 14 : 955, 1930–32.

Breadth of the trichome, 5.4-6.3 μ,
Length of the cell, 2.7-4.5 μ.

Habit: Planktonic.

52. **Oscillatoria brevis** (Kütz) Gom. Geitler, Rabenhorst, Kryptogammenflora, 14 : 977, 1930–32.

Breadth of the trichome, 4.57.2 μ.
Length of the cell, 2.7-3.6 μ.

Habit : Planktonic.

53. **Oscillatoria tereberiformis** Ag. Geitler, Rabenhorst, Kryptogammenflora, 14 : 954, 1930–32.

Breadth of the trichome, 4.5-5.4 μ.
Length of the cell, 3.6 μ.

Habit : Planktonic.

54. **Oscillatoria quadripunctulata** Brühl et Biswas in *J. Dept. Sci. Calcutta Univ.* 4 (S.5) : t. 1, f. 6, 1922.

Breadth of the trichome, 1.8 μ.
Length of the cell, 2.7-3.6 μ.

Habit : Planktonic.

55. **Calothrix fusca** Born et Flah. Geitler, Rabenhorst, Kryptogammenflora, 14 : 610, 1930–32.

Breadth of the filament, 3.6-12.6 μ.
Breadth of the trichome, 0.9-10.8 μ.
Breadth of the heterocysts, 5.4-7.2 μ.
Length of the heterocyst, 5.4-7.2 μ.

Habit : Epiphytic on aquatic angiosperms,

56. **Gleotrichia pisum** Thrret in *Ann. Sc. Nat. Bot.* (ser. 6) 1, S. 382, 1875.

Breadth of the trichome, 2.7-7.2 μ.
Length of the cell, 5.4-8.8 μ.
Breadth of the heterocyst, 7.2-9.0 μ.
Length of the akinetes, 43.2-56.6 μ.
Breadth of akinetes, 9-14.4 μ.

Habit: Epiphytic as mucilage balls.

57. **Aulosira fritschii** Bhârad. in *Ann. Bot.* 47: 117-43, 1933.

Breadth of the cell, 10.8-14.4 μ
Length of the cell, 5.4-14.4 μ.
Breadth of the heterocyst, 10.8-14.4 μ.
Length of the heterocyst, 19.8-36.6 μ.
Breadth of the akinete, 14.4 μ.,
Length of the akinete, 5.4-14.4 μ.

Habit: Free-floating.

58. **Anabaena affinis** Lemm. Geitler, Rabenhorst, Kryptogammenflora, 14: 894, 1930-32.

Breadth of the trichome, 5.4-6.3 μ.
Length of the cell, 5.4 μ.
Breadth of the heterocyst, 7.2 μ.
Breadth of the akinete, 5.4 μ.
Length of the akinete, 9-12.6 μ.

Habit: Free floating.

59. **Anabaena torulosa** (Carm.) Lagerh. Geitler, Rabenhorst, Kryptogammenflora, 14: 887, 1930-32.

Breadth of the trichome, 4.8-5.4. μ
Length of the cell, 3.6-4.5 μ.
Breadth of the heterocyst, 7.2 μ.
Length of the heterocyst, 7.2-9.9 μ.
Breadth of the akinete, 5.4 μ.
Length of the akinete, 11.7-12.6 μ.

Habit: Free-floating.

60. **Cylindrospermum muscicola** Kütz. var. **macrospora** var. nov.

Breadth of the trichome, 3.6-5.4 μ.
Length of the cell, 5.4-7.2 μ.
Breadth of the heterocyst, 5.4-9.0 μ.
Length of heterocyst, 7.2-10.8 μ.
Breadth of the akinete, 12.6 (-19.8) μ.
Length of the akinete, 27-45 μ.

This form differs from the type in the broader cells, bigger heterocysts and akinetes. It differs from var. *longispora* Dixit in bigger spores. Spores are even as broad as 19.8 μ and as long as 45 μ. The cells in the present form possess pseudovacuoles.

[A typo differt cellulis latioribus, heterocystis et akinetis largioribus; a var. *longispora* Dixit sporis maioribus. Sporae usque ad 19.8 μ latae, 45 μ longae. Pseudovacuola adsunt in praesenti forma.]

61. **Wollea bharadwajae** Singh. Singh in *Ann. Bot.* 6 : 593-606, 1942.

Breadth of the trichome, 3.6-4.5 μ.
Length of the cell, 3.6 μ.
Breadth of the heterocyst, 5.4-6.3 μ.
Length of the heterocyst, 6.3 μ.
Breadth of the akinete, 14.4-16.2 μ.
Length of the akinete, 16.2-21.6 μ.

Habit: Finger-like mucilaginous projections attached to the mud.

In conclusion, I am greatly indebted to Prof. Y. Bhâradwâja for his kind guidance and help throughout the course of this investigation. I am also grateful to Dr. R. N. Singh for his valuable suggestions and criticism.

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TERNS OF THE SEYCHELLES ISLANDS

BY

M. W. Ridley

(*With two plates*)

Several species of terns breed in the Seychelles Islands which lie about 1,700 miles south of Bombay. As many of these species also occur on the coast of India, this paper describing the various terns may be of help to ornithologists of that country in identifying them.

The author spent four months in 1955 studying the tern colonies of Seychelles at the request of the government of that colony, and most of the descriptions are taken from notes made in the field. Subspecific names have been used when specimens were obtained and identified by the British Museum (Natural History). The summer and winter plumages are identical unless otherwise stated.

In Seychelles the main breeding season for terns is from May to August, during the period of the south-east monsoon. Some species migrate to the islands only to breed, and are not seen at other times of year. Some are sedentary while other species are only seen on passage.

The terns mostly breed on small uninhabited islands, particularly those where access is difficult in the rough seas normally associated with the south-east monsoon, but some islands still have colonies on them despite the presence of permanent settlements. In the past the Sooty Tern in particular was much more abundant than it is now. The eggs of many species are cropped for human consumption in the season, and the business is one of some importance from the commercial aspect as well as from the point of view of the peoples' food supplies when fish is short.

The Seychelles number 92 islands in all, spread over an area about 600 miles long. The main sea-bird colonies are in the central group of islands known collectively as the Amirantes, but there are important colonies in the granite group, of which Mahe the capital is one, and in the Aldabra-Cosmoledo group to the south.

Sooty Tern : *Sterna fuscata nubilosa* Sparrman*

This is by far the most numerous species, providing the bulk of the egg crop. It is found in all the tropical oceans of the world and has been well studied (Watson and Lashley 1915, Chapin 1954). It breeds in the Laccadive Islands (Hume 1876) and occurs on the coast of India.

It is a migratory bird in Seychelles, appearing during April and departing when the young can fly, about October. No one knows where these huge numbers spend the rest of the year but they are seldom seen near land and it is possible that they are widely dispersed over the oceans. Where they go remains a problem which may yet be solved.

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* Terns marked with an asterisk evidently also breed on Vengurla Rocks on the Bombay coast opposite Malvan, but the subspecies here have not been determined (see *JBNHS*, 41 ; 661-665 ; 43 : 446-451). Eds.

Very large numbers breed on the Seychelles. In 1955 we estimated there were about 1,190,000 pairs on one island (Desnoeufs) alone. Vesey-Fitzgerald (1940), whose knowledge of Seychelles sea-birds is second to none, has said that there were 5 million pairs on this island in 1931. The other islands support populations from as low as 100 pairs to about 60,000 pairs.

A Sooty Tern colony is a very noisy place as the birds are always active by day and by night, and the clamour of their cries has earned them the name of 'Wideawake'. The nests, each containing one egg (two is accidental), are often placed very close together and a density of 3½ pairs to the square yard appears quite normal. An island covered with Sooty Terns is one of the most remarkable sights that an ornithologist can see.

The Sooty Tern is a large tern about 15 inches long. The crown, nape, back, wings, and tail are black, as also is a stripe between the eye and the bill. There is a white patch on the forehead which does not extend so far back as the eye. The bill and feet are black. The rest of the plumage is pure white. The wings and tail are very long and the feet short. The two outer tail feathers are elongated and white. Despite their pelagic habit, Sooty Terns apparently cannot swim, and drown if forced on to the water; they do not land at all except during the breeding season. It is thought that they sleep, feed, and even copulate in the air. Their food is chiefly small fish, flying fish, and squids; it is picked off the surface or caught in mid-air. The young are fed on regurgitated food by their parents.

The juvenile plumage is unlike any other tern, being dark grey all over with buff spots on the back and wings and white under tail-coverts. The first year birds, in my opinion, can be distinguished by a few grey feathers which are retained on the breast, though the plumage otherwise is the same as the adult. It is probable that, as with other terns, only a small proportion of birds breed in their first year.

The egg of the Sooty Tern is very variable in colour, normally white, speckled or blotched with violet or brown. Scarcely any nest is made.

Brownwinged Tern : *Sterna anaethetus antarctica* Lesson*

This species is very like a small edition of the Sooty Tern and like it is pelagic in habit. It is not nearly so numerous as the Sooty Tern and prefers small rocky islands for breeding purposes. It may be distinguished from the Sooty Tern by its smaller size, brownish back and wings, and by the fact that the white patch on the forehead is prolonged into a streak above the eye. Although it is only 12 inches long, it is at times easy to confuse with the Sooty Tern at a short distance, but in good light the brown back is generally visible.

The Brownwinged Tern nests underneath rocks or tufts of grass and not in the open. It also lays a single egg, buff in colour and spotted with various shades of brown.

The Brownwinged Tern occurs in all the tropical oceans of the world. Unlike the Sooty Tern it commonly perches and roosts in trees in Seychelles.

Common Noddy : *Anous stolidus pileatus* (Scopoli)

The Noddy Terns are well distributed throughout the tropical oceans of the world, and often occur on the same islands as the Sooty Terns both in the Old and the New Worlds. They breed also in the Laccadive Islands.

The name Noddy may be derived from its habit of sleeping on the masts of ships, or from its courtship in which the male and female face each other nodding their heads and displaying their bright orange gapes. It is generally a resident bird to be seen daily in Seychelles and some individuals undoubtedly breed throughout the year, although the majority nest in the months of the south-east monsoon (May-September). The breeding season is in any case much more prolonged than that of the Sooty Tern.

In size the Noddy Tern is very slightly larger than the Sooty Tern but the wings are shorter and the tail is rounded, not forked. It is of a uniform dark brown colour with a pale grey cap. The bill and feet are black.

The Noddy is a very versatile nester. It generally builds a nest of sticks, straw, shells, bones, or grass, and sometimes this nest is quite a substantial structure. It may be placed in the tops of coconut and other trees, in bushes, on rocks, or on the ground. The rockier sites are always chosen in preference to flat ground and the birds nest in compact colonies. The colonies on Desnoeufs Island, where there were some 36,000 pairs nesting in 1955, averaged about 87 pairs per colony. The Noddies were much shyer than the Sooties and it was hardly ever possible to pick up a bird from its egg by hand, which could be done with the majority of Sooties.

The single egg is white or cream in colour, sparingly spotted with brown towards the larger end. It is almost exactly the same size as the Sooty Tern's egg but can be distinguished from it by its more chalky texture and the colour of the yolk, which is yellow in a Noddy's egg and orange in a Sooty's.

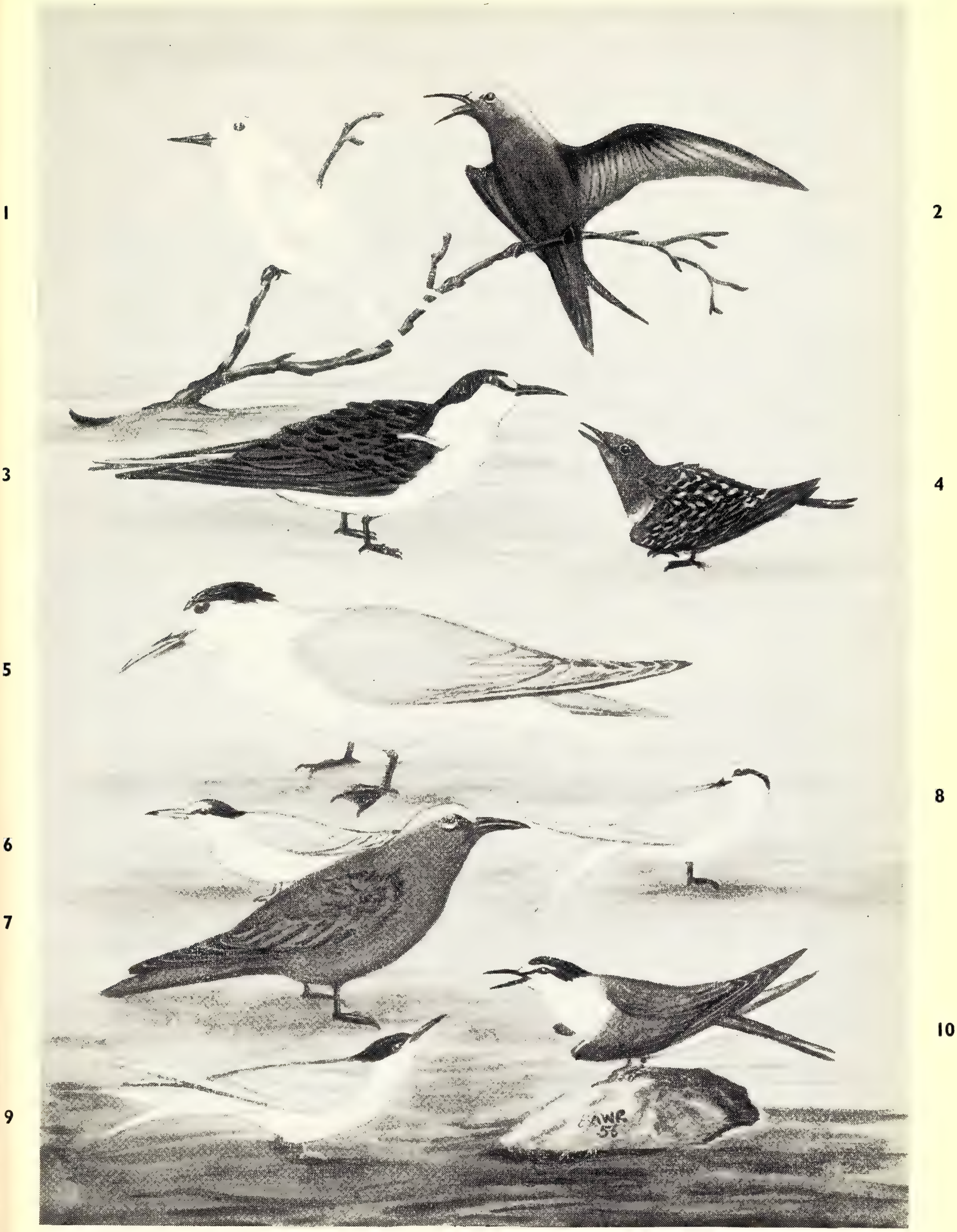
The young bird's first plumage is exactly the same as the adult's but the down with which it is covered on hatching is either dark brown or occasionally pale grey.

Lesser Noddy : *Anous tenuirostris tenuirostris* (Temminck)

The Lesser Noddy is a comparatively rare bird and is only found in the Indian Ocean where it breeds in Seychelles, near Mauritius, and the Houtmann Abrolhos Islands off Western Australia.

It is considerably smaller than the Common Noddy, but can be confused with that species. It is generally rather darker brown in colour and the white cap is whiter and extends further down the back of the neck. Its bill is much longer and thinner, which difference, together with proportionately longer wings and tail, helps to distinguish it in the field.

In the Seychelles at any rate, Lesser Noddies always seem to breed in trees, generally coconut palms, and the nests are always a good



1. White Tern, 2. Lesser Noddy, 3. Sooty Tern (adult), 4. Sooty Tern (young), 5. Crested Tern, 6. Little Tern, 7. Common Noddy, 8. Blacknaped Tern, 9. Roseate Tern, 10. Brownwinged Tern.

"An island covered with Sooty Terns is one of the most remarkable sights that an ornithologist can see" (Desnoeufs Island).

Photos : M. W. Ridley

(By courtesy *Country Life*)

height from the ground. The nest is much smaller and neater than the Common Noddy's and the egg is considerably smaller. We failed to distinguish any difference between the notes of the two species. Both are generally fairly silent birds except when they utter a loud, rather corvine-like call at intruders. The Lesser Noddy is one of the most graceful of all terns and flies more like a swallow than its heavier relative. We only found it breeding, in any numbers, on the islands of Cousin and Aride near Mahe, but a very few pairs also nest in the Amirantes.

Crested Tern ; *Sterna bergii thalassina* Stresemann*

This larger and well-known Indian Ocean species breeds in the Amirantes group of Seychelles. It is much the largest species and could only be confused with the Caspian Tern from which its yellow bill would distinguish it.

It seems seldom to cross high tide mark and flocks roost on the sand keeping together in silent flocks. It utters a faint mewing call, difficult to hear amid the screams of Sooty Terns, and appears to be a docile bird compared to the more numerous species. The nests are merely small depressions in the sand just above high water mark and placed very close together. The young have black and grey mottling on the wings but the adults are typical terns with white plumage, black caps, and grey mantles. The bill is lemon-yellow and the feet black. The eggs are handsomely marked and much larger than any other species of tern breeding in Seychelles.

Roseate Tern : *Sterna dougallii arideensis* Mathews*

This species is one of the most cosmopolitan of all terns. In Seychelles it breeds in fair numbers on several islands, notably Aride, Mamelles, and African Banks.

The subspecies *arideensis* which is the form occurring here, appears in the field to have more red on its bill than the British race, the basal half of the bill being scarlet and thus resembling the Common Tern. The Common Tern does not occur in Seychelles, but the pink breast of the Roseate would distinguish the two species. In winter the black cap is lost.

The Roseate Tern breeds in large colonies. From our limited experience only one egg is laid in the clutch, which is variable in colour with the usual dark markings of terns' eggs. The nests may be among rocks or on the bare sand. The birds often associate with Crested Terns.

Blacknaped Tern : *Sterna sumatrana mathewsi* Stresemann

This small and beautiful species was not seen in the Seychelles group of islands, but breeds on African Banks in the Amirantes. It is a very small graceful bird, almost out of place in oceanic surroundings, and yet is found on many islands in the Indian Ocean and the Pacific Ocean and has occurred on the Indian coast.

It can be distinguished by the black nape which does not extend on to the crown, and by its black legs and bill. At least in the breeding plumage, the breast is suffused with a very pale pink like the Roseate Tern. It seems to be a quiet bird nesting in scattered colonies on a few low-lying windswept islands such as African Banks, but is not common in Seychelles. The nest is a slight depression in the sand, and the single egg is pale green or buff, covered with small black spots.

White Tern : *Gygis alba monte* Mathews

The White Tern is one of the most charming birds of the Seychelles. It is common on nearly all the islands and also occurs on many tropical islands in all three oceans.

The White Tern is easy to distinguish. It is pure white all over with a large dark eye, small dark feet with white webs, and a long bill which is black with a blue patch at the base.

The peculiar breeding habits of this bird are its chief claim to fame. The single handsome egg is generally laid on a branch of a tree, no nest being made, and the egg is precariously balanced in some slight depression in the upper surface of the branch. Most birds nest at considerable heights on the more closely populated islands for obvious reasons, but on the smaller islands White Terns nest in bushes or on rocks or even inside buildings. When the chick hatches it is equipped with sharp claws with which it clutches the branch or rock, and it seems that it is seldom blown off its perch even in gales.

White Terns are very common on Mahe itself and in Port Victoria, the capital of Seychelles. They are to be seen fluttering in the trees everywhere, even high up the mountain-sides, and their raucous notes, almost a parody of a human being's laughter, are one of the characteristic sounds of the islands by day and by night. The adults feed their young with small fish which are brought home in neatly arranged rows in the bill.

The White Tern is a resident species.

Little Tern : *Sterna albifrons* Pallas

The Little Tern is primarily a Palaearctic species which nests in the northern hemisphere, including parts of India and the Near East, and migrates south for the winter. It visits Seychelles in the non-breeding season and is not known to breed there. It could only be confused with the Blacknaped Tern which has less black on the head. The Little Tern's black-tipped yellow bill and yellow feet would also distinguish it, and the white forehead prevents confusion with the Roseate Tern.

Caspian Tern : *Hydroprogne tschegrava* (Lepechin).

This species has also been recorded from Seychelles by Fitzgerald, but we did not see either this or the Little Tern during our visit there.

NEW PLANT RECORDS FOR SOUTH INDIA—II

BY

D. Daniel Sundararaj

AND

V. Ramakrishnan

Madras State Herbarium, Coimbatore

(*With two plates*)

(*Continued from Vol.* 53, *p.* 526)

In the present paper the occurrence of two new species, namely, *Lippia unica* spec. nov. Ramakrishnan and *Cenchrus glaucus* spec. nov. Mudaliar, C. R. and Sundararaj, D. in South India are reported with their descriptions.

1. **Lippia unica** spec. nov. Ramakrishnan

Suffrutex perennis, ramosus, gregarius, fortiter aromaticus, 90-120 cm. altus; culmis supra tetragonus, ad basim vero teres, immaturus pubescens, maturus vero glaber; spatia internodalia 5-7.5 cm. longa. *Folia* opposita, ternata, petiolata, elliptica vel elliptico-lanceolata, apice acuto, basi attenuata, 2.5-7.5 cm. longa, 12-33 mm. lata, serrata, serrationibus acutis; pagina superior pallide viridis atque villosa, inferior vero grisea atque pubescens; nervi primarii ascendentes, 7-9, supra impressi, infra eminentes, villosi. *Inflorescentia* axillaris, solitaria, spicata, subglobosa, 6-12 mm. longa, 7.5-10 mm. in diam. Pedunculi teretes ad basim, tetragoni atque canaliculati supra, villosi, 5-12 mm. longi. Bracteae subcordatae, acuminatae, pagina exteriore obscure jugata, villosa, interiore vero glabra, marginibus ciliatis, nervis prominentibus 4-5 ad utrumque latus nervi medii eminentis. *Calyx* distincte 2-lobatus, carinatus, ad basim connatus annulum efformans, dense pubescens extra, glaber intra, 1.25-1.75 mm. *Corolla* bilabiata, labello superiore constante duobus, inferiore vero tribus laciniis, lilacina, gutture luteo, 6.5 mm. longa; inferior pars dimidia alba et curvata, pubescens extra atque ex luteo gutture deorsum. *Stamina* 4, didynamia, inserta in prope medium corollae tubum; filamenta brevia, antherae ovatae, cellulis parallelis. *Ovarium* superius, sessile, subglobosum, constans duobus carpellis, syncarpum, bicellulatum; stylus terminalis, brevis et robustus, tenuiter curvatus; stigma terminale, obliquum, recurvatum, crassum. *Fructus* parvus, pyriformis, inclusus calyce paulum accrescente atque adpresso; endocarpium durum et oseum, faciliter separabile in duas uniseminatas pyrenas.

Typus lectus in Wetlands, in Agric. Coll. Estate, Coimbatore in Statu Madras, die 14 mensis aprilis anni 1952 a V. Ramakrishnan et positus in herbario Madraspatano sub numero 94281.

Praesens species differt a simili specie *L. geminata* H.B. & K. spicis solitariis, axillaribus, condensis, subglobosis, foliis ellipticis vel elliptico-lanceolatis, acutis, attenuatis ad basim, quarum pagina superior villosa est, atque bracteis subcordatis, acuminatis, ciliatis. In *L. geminata* H. B. & K. spicae sunt in unum vel duo paria dispositae, cylindricae vel elongatae; folia ovata, sub-obtusa, ad superiorem paginam scabro-hispidula pilis e basi papillosa surgentibus, nonnihil decurrentia; bracteae ovatae, apiculatae.

[**Lippia unica** spec. nov. Ramakrishnan

Perennial, gregarious, branching undershrub, strongly aromatic, 90-120 cm. high. Stem tetragonal above, terete at the base, young stems pubescent, older glabrous, internodes 5-7.5 cm. long. *Leaves* opposite, ternate, petiolate, elliptic to elliptic-lanceolate, apex acute, base attenuated, 2.5-7.5 cm. long, 12-33 mm. broad, serrate, serratures pointed; upper surface pale green and villous, lower greyish and pubescent; 7-9 ascending primary nerves impressed above, prominent villous beneath. *Inflorescence* in axillary solitary spikes, subglobose 6-12 mm. long, 7.5-10 mm. diameter. Peduncle terete towards the base and tetragonal and grooved above, villous, 5-12 mm. long. Bracts subcordate, acuminate, upper surface obscurely ridged, villous without, glabrous within and ciliate on the margin; nerves prominent 4-5 on either side of the prominent mid-rib. *Calyx* distinctly two lobed, keel shaped, connate at the base to form a ring, densely pubescent without, glabrous within 1.25-1.75 mm. *Corolla* bilabiate, upper two lobed and lower three, lilac with yellow throat, 6.5 mm. long, lower half white and curved, pubescent without and from the yellow throat downwards. *Stamens* four, didynamous, inserted near the middle of the corolla tube; filament short, anthers ovate with parallel cells. *Ovary* superior, sessile, subglobose, formed of two carpels, syncarpous, 2 celled; style terminal, short and stout, slightly curved; stigma terminal, oblique and recurved, thickened. *Fruit* small, pyriform, enclosed in slightly accrescent and adpressed calyx; endocarp hard and bony, easily separated into two one-seeded pyrenes.]

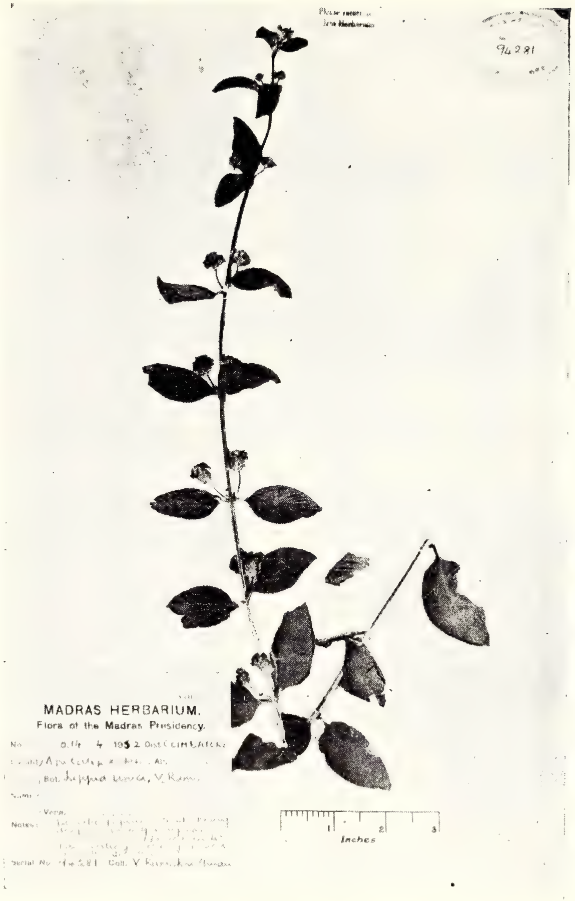
Coimbatore: Wetlands, Agricultural College Estate, Coimbatore 14-4-1952 V. Ramakrishnan, Madras Herb. No. 94281 (Type in Madras Herbarium).

This striking species differs from its allied species *L. geminata* H.B. & K. in its solitary, axillary, condensed, subglobose spikes, elliptic to elliptic-lanceolate, acute, attenuate based leaves with upper surface villous and in its subcordate, acuminate, ciliate bracts. In *L. geminata* H.B. & K. the spikes are in one or two pairs, cylindric and elongate, the leaves ovate, subobtuse with upper surface scabrous-hispidulous hairs with papilose base and somewhat decurrent and the bracts ovate, apiculate.

A shrubby species with virgate branches, strongly aromatic particularly the leaves and tender angular shoots smelling like citrol. The flowers are lilac with yellow throat. The plant thrives very well in moist loamy soils particularly along the bunds of irrigation channels. It easily roots at nodes.

2. **Cenchrus glaucus** spec. nov. Mudaliar, C. R. & Sundararaj, D. Affinis *C. ciliari* Linn.

Folia glauca; paniculus compactus et spiciformis; spicularum acervi confertim ordinati; inflorescentiae rhachis recta, haud flexuosa.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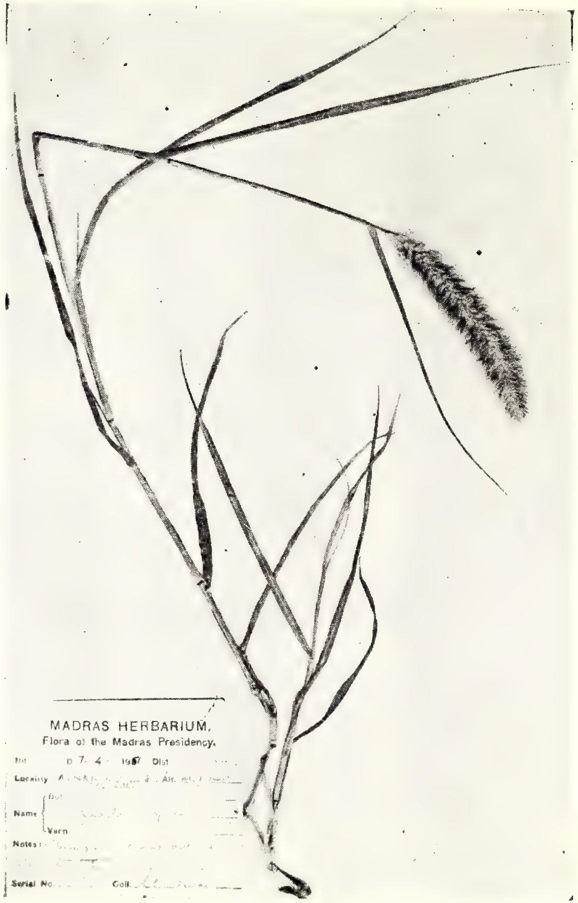
Lippia unica sp. nov.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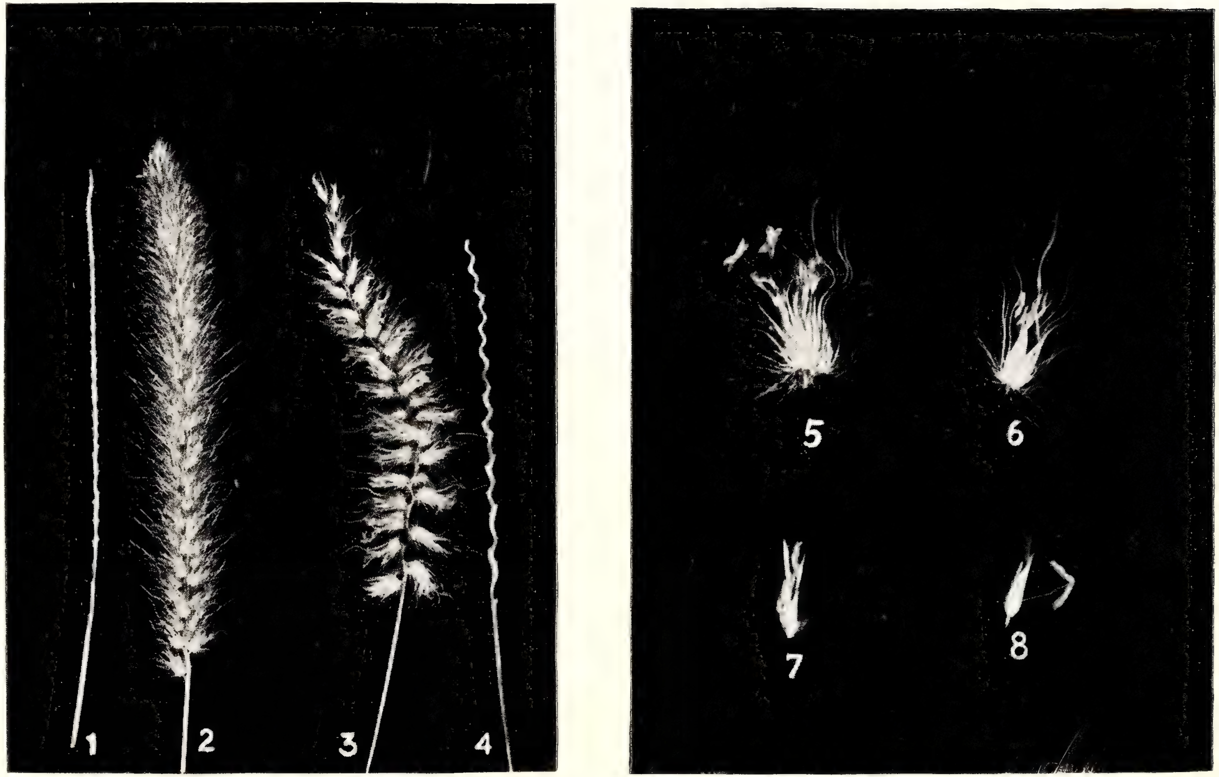
Cenchrus glaucus sp. nov.



Figs. 1, 2, 6 & 8 — *Cenchrus glaucus* spec. nov.
Figs. 3, 4, 5 & 7 — *Cenchrus ciliaris* Linn.

glaucus

6+8, Pennisetum

Planta perennis, rhizomifera. Basis foliaris et lamina glaucae; lamina pilosa usque ad 3 centimetra a puncto originis ligulae, sed tantum super facie adaxiali. *Inflorescentia* spiciformis, longitudine usque ad 10 centimetra longa, compacta; rhachis recta, haud flexuosa, imporcata. *Spicularum* acervi confertim super rhachi ordinati; setae involucrales filiformes, basi unitae in formam pocelli. *Spiculae* 1-3, raro 4, in sigulis involucris, angustae, lanceolatae; lemma inferius vel staminatum vel inane, saepe epaleatum; lemma superius paleatum, hermaphroditum. Granum oblongum, colore subfuscum.

[**Cenchrus glaucus** spec. nov. Mudaliar, C. R. & Sundararaj, D.

Perennial, rhizomiferous; leaves linear, 22-30 cm. long and 0.5-0.7 cm. broad; leaf sheath and lamina glaucous, veins prominent with distinct furrows in between; ligule scarious, fringed with hairs; lamina pilose up to about 2 cm. from the ligule on the upper surface. *Inflorescence* speci-form up to 10 cm. long, compact; rachis straight ridged not flexuose; clusters of spikelets set very closely on the rachis giving a compact appearance. Involucral bristles filiform, united at base forming a small disc, with 1-3, rarely 4, spikelets in each involucre. *Spikelets* about 5 mm. long and about 2 mm. broad, lanceolate; lower two glumes equal, 2 mm. long, ovate-obtuse, membranous with a single nerve, first lemma staminate or empty, invariably epaleate, 4 mm. long, lanceolate, 5 nerved; second lemma hermaphrodite, paleate, 5 mm. long, lanceolate, 5 nerved. *Grain* oblong, brownish, free within the lemma and palea.]

Coimbatore: Agricultural College, C. R. Mudaliar Madr. Herb. Nos. 93840 a, b & c (Type sheet in Madras Herbarium 93840 a) D. Daniel Sundararaj. Madr. Herb. No. 97150; C. R. Nachiappan, Madr. Herb. No. 97149.

The specific name of the plant is given from the most striking diagnostic character, the glaucous nature of the plant. The species differs from the closely allied species *C. ciliaris* Linn. in many distinct morphological characters as given below: (i) the rough glaucous leaves; (ii) stiffer culms; (iii) compactly set spiciform panicle; (iv) rachis of panicle more or less straight with ridges, but not flexuose; (v) the involucre of bristles connate below into a much smaller cup than in *C. ciliaris*; (vi) spikelets smaller and slender. (Compare figures in Plates I & II.) Besides the above morphological characters, in its growth form also the new species is distinct. The anatomical studies of the leaf, stem and root also bring out its differences from *C. ciliaris* Linn.

The plants of this species were noted in the National Dairy Research Institute, Bangalore. From a few slips obtained from there, it has been multiplied and distributed to the ryots of the Madras State as it is a hardy, drought-resistant grass, having very vigorous growth and forming big clumps.

ACKNOWLEDGEMENT

The authors are greatly indebted to Rev. Fr. H. Santapau, S.J., St. Xavier's College, Bombay, for the rendering of the English description of *Lippia unica* into Latin, and to Rev. Fr. L. M. Balam, S.J., St. Joseph's College, Tiruchirapalli, for that of *Cenchrus glaucus*.

OBITUARY

NORMAN BOYD KINNEAR

1882-1957

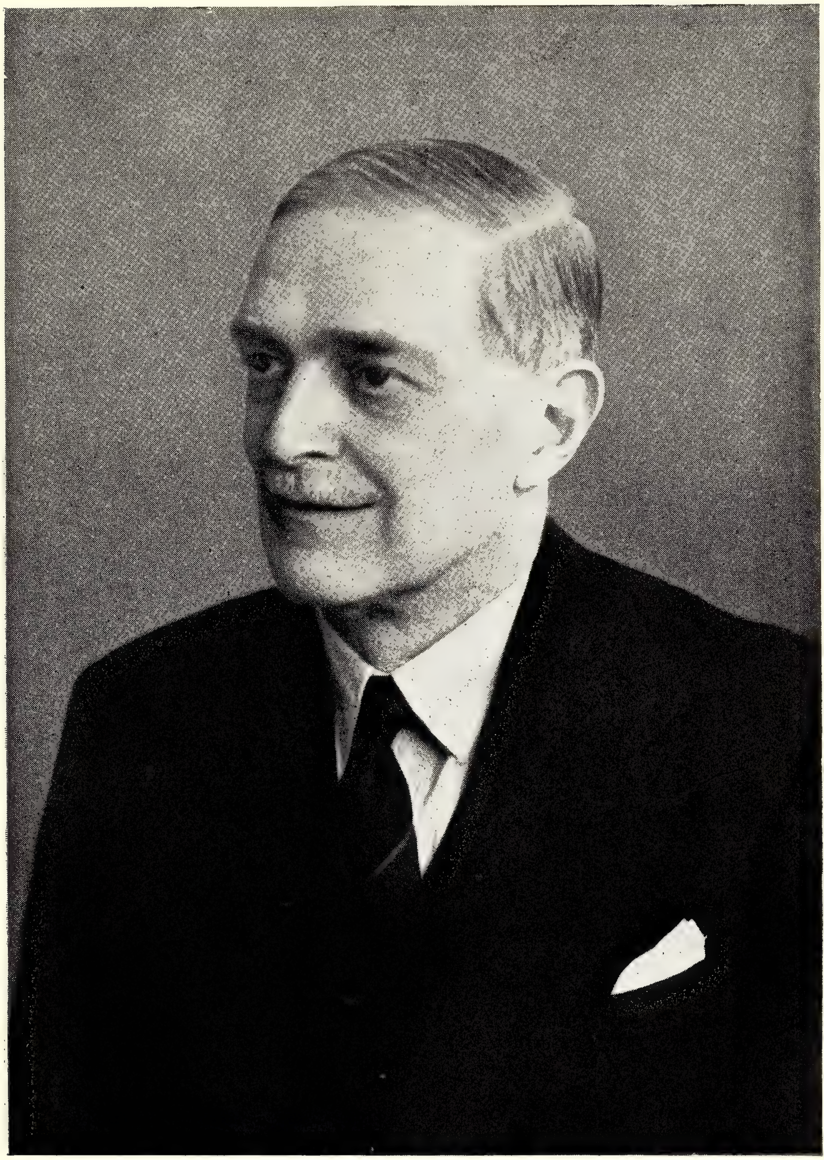
(*With a photo*)

Norman Boyd Kinnear entered the Society's service on November 1, 1907. Attracted from boyhood to Natural History, he had commenced his career as a voluntary worker in the Royal Scottish Museum, Edinburgh, where he came under the expert guidance and training of Dr. Eagle Clarke, the Director. Dr. Clarke was obviously a good judge of the character and abilities of the men training under him. It was his recommendation which led the Society to offer Kinnear the post of Curator of its Museum.

The need for a trained curator had been apparent for many years. During practically a quarter of a century of progress and development, the Society's collections had grown apace. This material, collected by enthusiastic amateurs, resident all over India, Burma and Ceylon now formed, particularly as regards Vertebrates, one of the most important collections representative of the fauna of this area. This mass of material was lodged in the Society's rooms at 6, Apollo Street, Bombay. It was looked after and maintained by several keen and devoted amateurs who gave up their evenings after office hours to this work—and one callow youth, fresh from school, who served as a general factotum.

This was the position when Kinnear took over as Curator. During his term of office Kinnear gave invaluable service to the Society by placing the whole of its museum on a sound scientific basis through the rearrangement, labelling and cataloguing of the collections. He brought to this work his gift of organization and a meticulous attention to detail which not only benefited the museum as a whole but also contributed substantially to the training of the small staff working under him. He was also able to provide more effective assistance to members of the Society who sought his help, and generally to guide the work of the Society in directions which produced greater scientific gains.

In 1911 the committee of the Society decided to undertake a systematic Survey of the Mammals of India, Burma and Ceylon. Professional collectors were engaged to secure a systematic series of skins and skulls of mammals, in order to provide material for a comprehensive study of the status, variation and distribution of mammals of the 'Indian Region'. Kinnear threw himself wholeheartedly into the direction and control of this enormous task. To Kinnear's lot fell the work of selecting the areas in which the collectors should work. In doing this he made a special effort to cover districts in which the earlier mammalogists collected with a view to replace missing 'Types'—and there were many—by 'Topotypes' obtained from localities from which the 'types' originated. To him



Norman Boyd Kinnear, C.B.

fell the task of assembling the enormous collections obtained; of provisionally identifying and cataloguing them and arranging for their dispatch to the British Museum in London. The great advances made in systematic mammalogy through the medium of the Survey were largely due to Kinnear's organization and the painstaking care with which this preliminary work was carried out.

During the Great War between 1915-1918, large collections of mammals, birds, reptiles and insects were sent to the Society by its members serving with the Expeditionary Force in Mesopotamia. Kinnear was then attached to Brigade Headquarters, Bombay, as Intelligence Officer, but he found time to prepare a pamphlet on the 'Animals of Mesopotamia'. It was circulated among officers and men serving with the Expeditionary Force and became a frequent book of reference and proved invaluable to all those who were collecting.

The scientific results of all this work, which appeared in a series of papers in the journal of the Society between the years 1918-1923 were in no small measure due to Kinnear's guidance and control, and to the help and advice he gave. To his building the Society owes the progress and development of its museum on sound lines, and the staff the training which stood them in such good stead in after years.

Kinnear resigned his post as Curator of the Society's museum in November 1919. During his term of office he also served as one of the Editors of the *Journal*.

By a special appointment he entered the service of the British Museum (Natural History) in 1920 as an assistant in the Bird Department. During his years of service in India he had acquired an extensive knowledge of the bird life of the Region and he soon made his mark as an ornithologist. Eight years after joining the service he was appointed Assistant Keeper, and by 1936 had risen to the post of Deputy Keeper in charge of the Bird Department. Since his resignation the Society had undertaken the Vernay Scientific Survey of the Eastern Ghats. The desirability of an ornithological survey of this area of India had long been in the minds of workers. The important bird collections obtained by this Survey were worked out by Kinnear in collaboration with Mr. Hugh Whistler, another distinguished ornithologist. The results of this survey were published in the Society's journal under their joint authorship.

Kinnear continued as Deputy Keeper of Birds till 1945 when he was appointed Keeper of Zoology. The day after he had attained the age of 65—the normal age of retirement—the Trustees took the exceptional step of appointing him Director. The practice of offering this appointment to men outside the Museum Service had caused much discontent among the regular staff. Kinnear first regarded his appointment as purely temporary, but events proved that the Trustees' selection was fully justified. The staff were well content with the appointment and equanimity was restored due in a large measure to Kinnear's personal qualities—an unfailing kindliness and courtesy to all who approached him. Though brief, his tenure of office was remarkably successful.

A good administrator and organiser, he gave to the British Museum, as he had given to the Society, exceptionally valuable service. He was also prominently associated with other scientific societies, among them the British Ornithologists' Union of which he was President from 1943 to 1948. He was at various times a member of the Council of the Zoological Society of London, of the Home Office Advisory Committee for the Protection of Birds, and of the Council of the National Trust.

Kinnear was born on August 11, 1882, the son of C. H. G. Kinnear an Edinburgh architect. He was educated at the Edinburgh Academy, Glenalmond. In 1948 he was made a C.B. and knighted two years later. In him the Society loses one of its links with the past who contributed outstandingly to its progress and who will be remembered by all who knew him as a kindly and generous helper and friend.

S. H. PRATER

PHILIP McDONELL SANDERSON

1884-1957

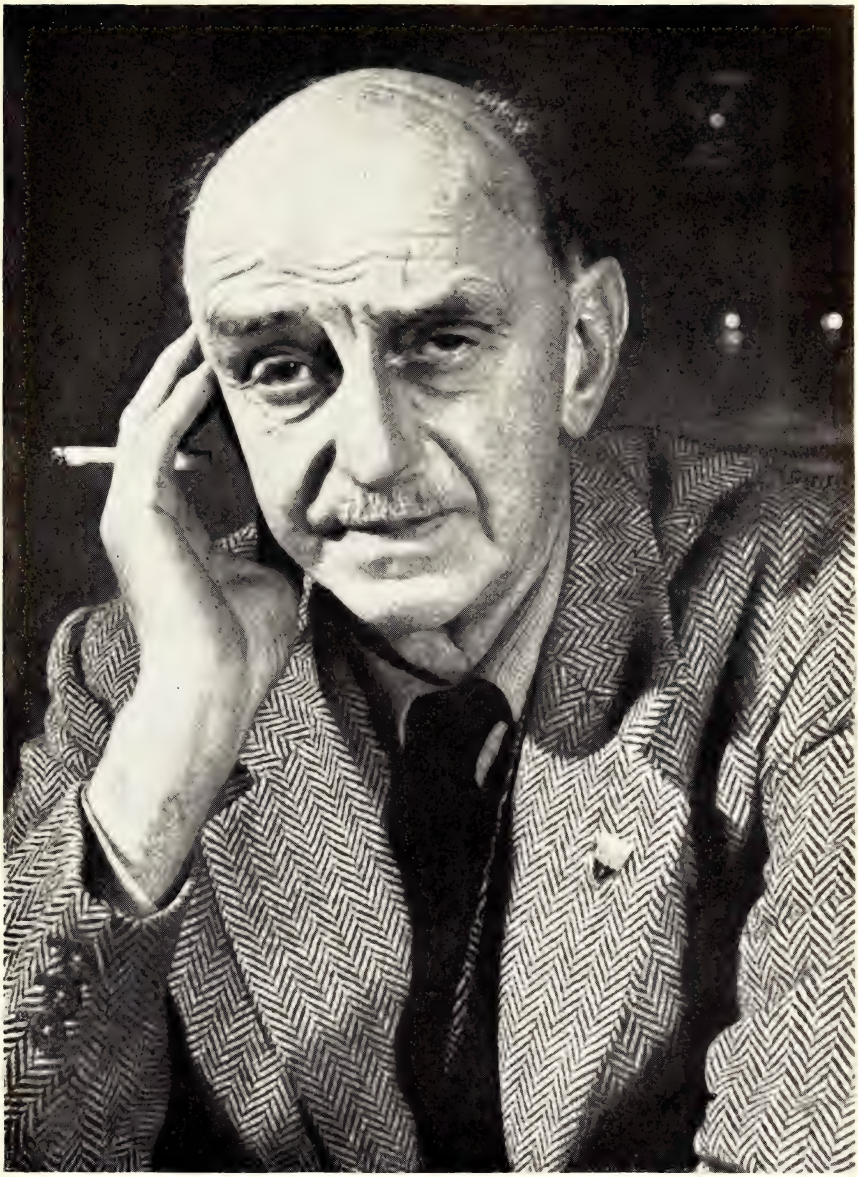
(*With a photo*)

This number of the *Journal of the Bombay Natural History Society* is rather a sad one, as it records the death of two men who have done great work—in perhaps different ways—for the Society. S. H. Prater records what Sir Norman Kinnear did for Natural History, and I wish to record, in lighter vein perhaps, what N. B. K.'s friend and fellow worker did for the Society.

P. M. D. Sanderson was born at Elstree School in 1884, which his father, Launcelot Sanderson—a former Harrow School Master—had founded as a preparatory school mainly for boys wishing to gain admission to Harrow. Phil Sanderson himself did not go to Harrow like his elder brothers, but went to Malvern, a great racquet school. He won the racquets tournament in Bombay twice in three years.

From Malvern, Phil went to Selwyn College, Cambridge, and kept up his cricket and racquets as well as his Greek. It was amusing to hear him and W. A. Haig Brown (a Wykehamist and son of the man who moved Charterhouse School from London to Godalming) cracking jokes in Greek at the Bombay Gymkhana bar. Alas, it was 'all Greek' to the writer of this tribute, who had to leave all corrections dealing with Greek in the Bombay Natural History Society's journal to Phil.

In 1905, P. M. D. Sanderson came out to join the firm of Phipson and Co., the partners in which, H. M. Phipson and W. S. Millard, were responsible for the nurture of the Society's museum and journal. Sanderson travelled out with Mr. and Mrs. Millard and their elder niece Ethel Millard. There was an interesting family sequel. Staying with the Millards was Mr. Kemball, at that time Secretary to the Government of Bombay in the P.W.D., and his sister. The sister took Ethel Millard under her wing for a tour through India, and wherever they went they kept on meeting a friend of the Millards,



Phillip McDonnell Sanderson

Alan Hay! The natural result—Ethel Millard became Ethel Hay, and shortly afterwards a younger sister, Gwen, came out to stay in Bombay with her uncle and aunt; and she married Norman Kinnear. Alan Hay was a great chess player, so was Phil Sanderson. Phil had married in 1917 Eilleen Rendall, a niece of the Headmaster of Winchester. The families saw a great deal of each other, with the result that Phil Sanderson's elder daughter married the elder son of Ethel Hay. Thus W. S. Millard became the uncle by marriage of Norman Kinnear, and the great-uncle of Phil Sanderson's daughter.

With Phipson and Millard to work with, it was natural that Sanderson took an interest in the Natural History Society's affairs and this was increased when Norman Kinnear came out to work in the Society's Museum in 1907.

The partnership was broken for a short time from 1914 to 1919. Phil was at home yachting off the coast of Scotland when the first Great War started. He immediately left his yacht in Scottish waters and came south to join up. He was then 30 years of age—'much too old to be a Second Lieutenant'. He got over that hurdle by telling his friend Colonel Fitzgerald, Lord Kitchener's Private Secretary, of his military experience prior to the War. 'Served in the Artillery'—Malvern Cadet Corps. 'Joined the Cavalry'—the Bombay Light Horse—'Thought he would be more appreciated in the Infantry so joined the Gymkhana Company of the Bombay Volunteer Rifles'! Reward, 'You are too old for a Second Lieutenant, here is a commission as First Lieutenant in Kitchener's Army!'

Sanderson joined the 9th Battalion of the Worcestershire Regiment, commanded by Colonel Faviell, a great Worcestershire cricketer, and went to Gallipoli with the 13th Division under General Maude's command. From Gallipoli he went out to Mesopotamia. The immediate job there was the relief of Kut, and I am reminded by Sir Patrick Cadell, of a story confirmed to me in the Yacht Club Bombay by the padre of the battalion. When Sanderson was going through the Canal with his Regiment he bought a bottle of Lager Beer and bet a fellow-subaltern that he would carry that bottle in his haversack and not open it until Kut was relieved. Alas, he was dangerously wounded in 1916 in one of our battles for Kut, and as he was being carried out of the trenches he was met by the padre going back into the danger zone after looking after some of the other badly wounded men. 'I hope there is nothing for you to worry about,' said the padre. 'There is,' said Sanderson, 'I have left my haversack with the bottle of beer in the trench.' 'I will go and fetch it for you,' said the padre. Alas, he was too late. Beer was Beer and the lucky ones left in the trench were drinking the health of their very popular officer, known to them because he was so thin, as the 'Pull-through', and to us from the resemblance of his nose to the Great Hornbill in Phipson's office, as 'The Bird'.

Sanderson was seriously wounded, and we were very worried about him when the hospital ship reached Bombay, but he recovered sufficiently to be sent home in another hospital ship. He was awarded a life wound pension when the War came to an end.

Sanderson returned to Bombay with his wife and elder daughter in 1919, and in March 1920 when W. S. Millard left India, joined the writer as Joint Honorary Secretary of the Society and, with Norman Kinnear, the three edited the *Journal*. In 1934 Sanderson became the sole Hon. Secretary and edited the journal with the help of S. H. Prater and later, Sálim Ali.

Sanderson was very keen on Prater's work to make a real Museum of Natural History in the Prince of Wales Museum, and he had the privilege of running the arrangements for the Golden Jubilee of the Society, and the formal opening of the Museum of Natural History.

He left India in 1939, and on the outbreak of the Second War joined the Home Guard Commandoes—a very 'hush-hush' branch to the rest of the Home Guards, and one which put a big strain on those active in it.

When, owing to advancing age, W. S. Millard had to give up his work in London, Phil Sanderson took on his post as the Society's representative in England. Two years ago he had a very bad attack of shingles which played havoc with his health, though his friend did not realise it. At the memorial service to his old friend, Sir Norman Kinnear, on the 23rd of August this year, he, with S. H. Prater, represented the Society. I had a bad shock when I heard from Prater how ill Phil was looking, but I did not think that I should hear from his son-in-law, Alec Hay, on the night of Sunday the 8th of September that our friend had died that morning from a heart attack. I wrote earlier on that Phil Sanderson was a great chess player. When he had his first heart attack the morning of September 8th, he was taken to the Cottage Hospital close to his home, 'Tassels', at Tenterden, Kent. He seemed at first to be all right and told the surgeon, an old chess crony of his, that he wanted a game with him. The doctor agreed, and I understand it seemed to do Phil good, but alas, he had another heart attack later on and passed over that afternoon.

The Church at Tenterden is a fine and big one, but it was nearly filled for the Memorial Service on the 18th September. The lesson was read by Phil's eldest nephew, the present Headmaster of Elstree. It was very applicable. It was the Prayer Book version of the 15th Psalm which, I believe, is still read at Prayers before work starts in the House of Commons, and is known as the 'Gentleman's Psalm', because it gives the best definition of a gentleman, of whatever race or creed one may be. It ends 'Whoso doeth these things: shall never fall'. Read it, and you will agree with me. No better tribute could have been paid to 'The Bird', Philp Sanderson.

REGINALD SPENCE

REVIEWS

1. THE EVOLUTION OF MAN. By Fr. M. Hermanns, S.V.D. Pp. viii + 139 ($8\frac{1}{4}'' \times 6\frac{1}{2}''$). 1 photograph and 14 text-figures. Allahabad: Society of St. Paul. 1955. Price Rs. 3.50.

Very few scientific hypotheses have evoked so much controversy as Darwinism. It is now a hundred years since Darwin gave to the world the concept of organic evolution through Natural Selection, and his postulate about the descent of man from simian ancestors. The storm that raged over England and the European continent after the publication of Darwin's views, has now happily passed over, and Darwinism has come to stay though not in exactly the same form. Yet, there are occasional outbursts of emotion challenging what seem to be the most logical deductions on the basis of overwhelming scientific evidence. Father Hermanns's book EVOLUTION OF MAN is one such outburst—a challenge to Darwinism through human biogenetics, physical and cultural anthropology, prehistory and palaeontology. The challenge, however, does not appear to be so much directed against Darwin, as against M. R. Sahni or J. Manchip White who 'believes himself competent to make "scientific" statements concerning every aspect of man'! That the above gentlemen have provoked the author into writing this interesting thesis about evolution of man is very clear from the Introduction of the book.

The book has six chapters beginning with a four-page introduction which gives the idea that these 'real facts and results of sincere research' are meant to correct erring anthropologists, journalists and writers of popular science literature who believe in Darwinism as Gospel truth. The remaining 135 pages contain the subject matter divided into five unequal chapters on (i) The Genotype of Man, (ii) The Phenotype of Man, (iii) Prehistory and Cultural Anthropology, (iv) Palaeontology and Evolution of Man and (v) Conclusion.

The largest space is, of course, devoted to prehistory and cultural anthropology, where the author feels completely at home. The other topics are dealt with in less detail and do not at places conform to the facts as observed by biologists. It becomes clear as one makes one's way through the maze of disconnected ideas and arguments that the author has mercilessly exploited the weakest links in the chain of facts and deductions that form the basis of the concept of evolution. He has profusely quoted a few authors who have expressed their doubts about the validity of the evolution theory, but has avoided to use the overwhelming scientific material which has accumulated during the last hundred years reinforcing the basic premises of Darwinism and evolution. Nobody denies that the concept of evolution is not infallible, yet an objective assessment of the evidence that we have so far available, undoubtedly indicates that this concept is a logical consequence of the rationality of man, and he should not feel shy about his kinship with animals which are as much a part and parcel of nature, as he is. It is quite likely that in course of time the unexplained and ununderstandable aspects of the evolution theory may shrink beyond recognition when the vastly improved techniques of research give us greater insight into the complicated processes of life.

The chapter on Genotype of Man contains very little about genetics. It begins with a query—'What is Man?' and supplies the answer from the creation myths, from folklore of the Lepchas of Sikkim, and from various religious sources. Haeckel's views about evolution are brushed aside as 'clever subterfuge'. The author does not seem to be clear about the definition of evolution—he thinks for instance that 'a chicken evolves from an egg'! He further groups evolutionary ideas into four categories—atheistic evolution, deistic evolution, theistic evolution and special creation. The author is an advocate of special creation, though he concedes that evolution does occur 'within the limits of natural races, species and genus'. The rest of this chapter discusses atom and cell, what is life, and under the heading human genetics topics styled as 'the source of life', 'the organs of human life', 'ontogenesis and phylogenesis', and 'the immature human baby'; the chapter concludes with 'Mendelism and Mutation'. His conclusions are: 'inorganic matter cannot evolve into an organic cell'; the principle of life is 'entelechy' though not in an Aristotelian sense—there are three types of entelechies these days, the vegetative entelechy looking after the interests of the plant kingdom; the sensitive or psychical entelechy guiding the vital processes of animals other than man; and the rational or spiritual entelechy of man or the human soul. The entelechies are not transferable, that is, vegetative entelechy cannot change into human entelechy etc. 'We have the following hierarchy: the physico-chemical rules are transferred by vegetative and sensitive entelechy into the higher order of vegetative and sensitive life, and the biological laws of plant and animal kingdom are transformed by the human spirit into the higher order of spiritual life. There is no blind evolution from matter into plant, from plant into animal, and from animal to man! Having firmly established the entelechies, it is not difficult to explain other things, as whatever cannot be explained otherwise can be attributed to the miraculous powers of the entelechies!

The chapter on 'Phenotype' of man discusses the pre-human and human fossils dating from Pleistocene onwards, and here the author concedes that evolutionary forces were responsible for racial differentiation in man and his human predecessor, somewhat along Darwinian lines, but with a rider that these forces were active within the limits of the family Hominidae only, which is of course formed by an essential entelechy.

The chapter on Prehistory and Cultural Anthropology is interesting because here the author treads on familiar ground. Apart from its dubious value in the understanding of human evolution, this chapter contains interesting information about cultural life of many primitive races, specially those of the Indian region. The chapter, like the earlier ones, ends with the oft-repeated assertion about the non-animal origin of man through the so-called spiritual entelechy!

The chapter on Palaeontology and Evolution of Man hinges on the following points: (1) The discontinuity of types of life between various geological strata; (2) and the great insufficiency of fossil records. The discrepancy in the fossil record is interpreted to brush aside the importance of the time element in evolution, while the discontinuity of types in different strata is utilised for the assumption of sudden appearance of different families and orders etc. The still little understood problem of rates of formation of species and the radical structural differences between different groups, according to the author, rule out the possibilities of gradual evolution of different types which would have taken a much longer time than the age of the earth itself. The author poses the question that if mammals gradually evolved from reptiles, how did the structural transformations occur?

Our present knowledge about the mechanism of speciation and rate of species formation is not sufficient to give a satisfactory answer to this question. Modern genetical researches prove that the rate of variations in species may either be determined by generation-time in which case the changes will be quicker and induced by genotypic factors, or by environmental factors depending upon absolute time. This should partially help to explain the above questions since the changes that were determined by generation-time must have occurred very quickly leading to sudden multiplication of species. It is also apparent from present-day taxonomic studies that, barring a few exceptions, groups with shorter span of generation-life show much greater diversity in the number of species and genera than those where the span of generation-life is longer.

The essence of the author's thesis about evolution of man can be summarized as follows:

Phyla, Classes, Orders and Families sprang up suddenly and simultaneously through a creative act without any transitory stages —through *creative evolution* or *macromutation.* The essential entelechies of these categories were virtually and latently existent and remained recessive till suitable conditions of life were present when they could become creative, active and dominant. The author even suggests that all the different categories of the various life-kingdoms were virtually and potentially created when the first life was created and that they came into activity when conditions were fit for their active existence!

The Genus, however, is constituted through adaptation, and hence requires evolution. Everything below a genus has evolved.

In the case of man, his spiritual entelechy or soul was first created out of nothing (!), and this entelechy developed an animal's body into a human body! Since each family requires a creative evolution, and luckily for the author, the family Hominidae to which man belongs contains a single genus—*Homo*—so man as the sole representative of his family demanded creative evolution. Because of man's 'peculiar somatic family-type' and because of his intellectual type, a special family was needed through special creation.

Father Hermanns's theory about evolution and special creation of man is an extreme manifestation of the anthropocentric point of view. Darwinism has its stoutest opposition from religion, because it for the first time exploded many religious dogmas that sapped the vitality of human society. But the firm roots that the concept of evolution has now got in the thought process and activity of man, make it ridiculous to indulge in thoughtless criticism of this concept. The tailor-made evolution theory suggested by the author, therefore, conforms to a pattern that can satisfy religious dogmas, compromise modern scientific thought by conceding partial evolution and accepting the existing systematic categories like Phylum, Class etc., and also boost up the human ego by saving man from the humiliation of believing that his ancestors were simian. It is undeniable that much of the criticism and anger against Darwin is due to the fact that he dragged in man along with other animals. If he had left man alone, probably his theory would have got a very smooth sailing.

Father Hermanns has stumbled into the same error which he wanted to correct in others. His thesis would have been all right if his concept about Phylum, Class, Order etc. had been the same as accepted by biologists. From the scientific viewpoint species are the only objective realities in the living kingdom—species consisting of populations of individuals sharing certain characters in common. Each species has its own chromosome-gene system irrespective of whether it is a plant, animal or man! All other systematic categories are only convenient taxonomic units devised for the purpose of an orderly classification of the animal and plant kingdoms, and there is a frequent reshuffling in their positions and make-up with increasing researches. Without Species, the Genus has no reality. Families are assemblages of one or several genera and each Order contains several families, and so on. It appears, therefore, ridiculous to think that creation began from the Phyla downwards. It sounds rather like beginning with the construction of the top-storey of the Empire State Building and then proceeding downwards to accommodate the upper storeys till the foundation is dug last!

K.K.T.

2. PHARMACOGNOSY OF AYURVEDIC DRUGS (KERALA)

Series No. 3. By K. Narayana Aiyar, M.A., A. N. Namboodiri, M.SC., and M. Kolammal, M.SC. Pp. ii + 109 ($9\frac{3}{4}'' \times 7\frac{1}{4}''$). 8 coloured and 29 black and white plates. Published by the Central Research Institute, University of Travancore, Trivandrum. 1957.

This volume, designed to provide important features of pharmacognostic studies on some useful medicinal plants growing in the State of Kerala, is the third publication of the Institute's first series. The monographs provide data for identifying several medicinal plants particularly belonging to the same genus, for instance *Albizzia*, etc. The present book is divided into eleven chapters. At the beginning of each chapter Ayurvedic notes, the properties and uses of the plants, and Sanskrit synonyms are given. Distribution and habitat, followed by external morphology, histology, and diagnostic features, form the general pattern in describing each plant.

In the first chapter, *Albizzia marginata*, *A. lebbeck* and *A. odoratissima* are fully described with morphology of the plants and illustrations of transverse sections of the barks. It would appear that the barks look similar histologically, but no attempt has been made to differentiate them. *A. odoratissima* does not have prismatic crystals of calcium oxalate like the other two barks. The second chapter deals with Nimb or Neem—*Azadirachta indica* A. Juss. The morphology of its bark is illustrated beautifully by a coloured plate. It is important to note that the transverse section of the young bark shows stone cells while the older bark is stated to contain groups of schlerides. A longitudinal section of the bark might have indicated whether the schlerides consist of fibres only or fibres associated with stone cells. 'Saptaparnah' is a useful plant from the medicinal standpoint. It is interesting to note that schlerides (fibres) are present in the young bark in the phloem region, while they are absent from the old bark which is full of stone cells in the secondary cortex. The transverse sections of the bark and petiole of *Murraya koenigii* are described with illustrations. The leaf is stated to have medicinal properties. Histology of the leaf would have been useful. The monograph on *Acorus calamus* is very informative. The coloured plate and the histological details will be found useful as this plant is already described in Indian Pharmaceutical Codex. 'Lodh'—*Symplocos racemosa* Roxb.—has been described in several books on indigenous drugs. The chapter on *Symplocos spicata* Roxb. which grows in Travancore/Cochin, will help to compare it with *S. racemosa* Roxb. growing elsewhere. One surprising feature of the book is that it does not contain any references. Similar work carried out on certain plants growing elsewhere has not been taken into consideration. Nevertheless this detailed botanical information on the medicinal plants of Kerala will certainly prove to be of great use to pharmacognosists.

B.C.M.

3. ZOOLOGICAL PHOTOGRAPHY IN PRACTICE. By HUGH B. COTT, SC.D., D.SC., F.R.P.S. Pp. 370 ($8\frac{1}{2}'' \times 6\frac{1}{4}''$). With 68 plates and 38 text-figures. Fountain Press, London, 1956: 52/6 *sh.*

Dr. Cott has written a text-book on zoological photography which both the beginner and the specialist will find of the utmost use; it combines an intimate and clearly-expressed knowledge of theory with great practical know-how. The author is an eminent scientist whose book ADAPTIVE COLORATION IN ANIMALS first published in 1940, has become a classic. When he was assembling data for this earlier book, Dr. Cott collected evidence in the field both in his own country and abroad, and the remarkable photographs which were such an important complement to its text—a number of these same pictures are reproduced in the present volume—showed how effectively the author had used his camera. Among the most interesting and original chapters in the new book are those which deal with the scientific approach to photography, and with work in the field; they show the combination of the scientist and practical photographer to best advantage, and they are enlivened with amusing experiences, and practical hints which are the result of personal knowledge.

ZOOLOGICAL PHOTOGRAPHY IN PRACTICE is divided into eleven chapters: the first six deal with the choice and use of equipment and materials; the seventh deals with the 'artistic approach to zoological photography'; the eighth with the scientific approach; the next two describe the opportunities and difficulties that await the photographer in rain-forest, and desert and savannah; and the last is concerned with the classification of animals. There are 68 plates on art paper at the end of the book: they are a testimony to the skill of the author as a photographer, and the explanatory texts which accompany them an equal testimony to his knowledge as a scientist; each caption is well-worth reading. The book is made complete by a full bibliography and an index.

Dr. Cott belongs to the school of zoological photographers who believe that it is the large negative, and hence the large camera, which gives the best pictures; most successful animal photographers would agree with him. He is careful to point out, however, that although this can be regarded as a general rule, it would be unwise to claim that there exists any camera which can be equally suitable for all types of zoological work; the miniature (35 mm.) camera, for instance, is, as Dr. Cott rightly says, the ideal instrument 'for fast work in very bad light or in artificial light, and in its adaptation to exceptional subjects requiring speed and depth of field, such as birds on the wing, or flash photography of fast-moving animals'. No large camera using a quarter-plate negative could possibly compete in this field.

The advantages and disadvantages of various types and sizes of cameras are thoroughly discussed in the first chapter, and the conclusion reached that the naturalist-photographer who sets himself a high standard in the rendering of texture and critical detail will generally choose the larger instrument. For him, indeed, the limiting factor may well be the weight he is prepared to carry'. Dr. Cott's own camera is a 'Sanderson quarter-plate model in teak and brass'. It seems a pity that in his affection for the camera which has served him so well, Dr. Cott makes scant mention of more modern makes which have the same flexibility and range, but with greater refinements, such as the Linhof or the Speed Graphic, although it must be admitted that the latter camera is more limited in its movements.

The book contains a wealth of practical advice which every photographer of animals would do well to study. Valuable chapters deal with the choice and use of apparatus and accessories, the theory and practice of exposure, negatives and development, and the print and the lantern slide. Dr. Cott expresses the views of a man who has travelled widely and used his camera under many different conditions, and it is with gratitude that we receive a book set down in readable English, written with economy and style.

Few people, I think, would disagree with Dr. Cott's general conclusions. My only criticisms are that the author is so faithful to the somewhat old-fashioned types of equipment and materials which have served him well that he sometimes overlooks new developments; there *are*, in my opinion, modern tripods with pan-tilt heads which are strong, steady and light; plastic bags have taken the place of blankets to prevent dust from reaching delicate equipment; cameras and films can now be kept dry in airtight containers in which a compound like silica-gel has been placed; and I would dispute the conclusion that the advantages of using plates so far outweigh their disadvantages that they are to be preferred to the filmpack.

These are, however, small objections when we consider the manifold qualities of a book which is written so well by that rare combination, a scientist-photographer who is also an artist—one who believes that 'if the photographer lacks vision, or any feeling of reverence for his subject or any rightness in composition, his work must tend to be a mere recording of events and recounting of anecdotes'. Dr. Cott's own pictures show that he is no mere recorder of events, and if he recounts anecdotes, he does so with wit and grace. No serious photographer of animals can afford to neglect this book.

W.-T.L.

ADDITIONS TO THE SOCIETY'S LIBRARY

The following books have been added to the Society's library since August 1957:

Review copies:

1. Voices of the Wild. By Eric Simms (Putnam & Co. Ltd., 42 Great Russel Street, London W.C. 1, 1957).
2. Professor Himadri Kumar Mookerjee Memorial Volume: Proceedings of the Zoological Society. Edited by J. L. Bhaduri, B. Biswas, S. P. Ray-Chaudhuri (The Zoological Society, 35 Ballygunge Circular Road, Calcutta 19, 1957).
3. On the Trail of Vanishing Birds. By Robert Porter Allen (McGraw-Hill Book Co., Inc., New York, 1957).
4. Centenary Souvenir of Lalbagh Botanical Gardens 1856-1956 (August 1957).
5. A General Text-book of Entomology. By A. D. Imms. Extensively revised by Prof. O. W. Richards and R. G. Davies (Methuen & Co. Ltd., 36 Essex Street, Strand, London W.C. 2, 1957).

Purchased:

1. The Snakes of Australia. By J. R. Kinghorn (2nd edition) (Angus and Robertson, Sydney, 1956).
2. The Bird Watcher's Reference Book. By Michael Lister (Phoenix House Ltd., Charing, London, 1956).
3. Australian Birds. By The Shell Company Ltd. (Angus and Robertson Ltd., Sydney and Melbourne).

Presented:

1. Mendelism. By Reginald Crundall Punnett (5th edition) (Macmillan & Co. Ltd., St. Martin's Street, London, 1919).
2. Soviet Genetics and World Science: Lysenko and the Meaning of Heredity. By Julian Huxley (Chatto and Windus, London, 1949).

3. The Science of Life. By H. G. Wells, Julian Huxley, G. P. Wells (Cassell & Co. Ltd., London, 1931).

4. Wild Life Illustrated. (Odhams Press Ltd., Long Acre, London, W.C. 2).

5. The System of Animate Nature. By J. Arthur Thomson (Williams & Norgate, London, 1920).

6. Bandoola. By J. H. Williams (Rupert Hart-Davis, Soho Square, London, 1953).

7. Elephant Bill. By Lt.-Col. J. H. Williams (Rupert Hart-Davis, London, 1952).

8. Biology for Everyman, Vol. I & Vol. II. By J. Arthur Thomson. Edited by E. J. Holmyard (J. M. Dent & Sons Ltd., London, 1934).

9. The Story of Animal Life, Vol. I & Vol. II. By Maurice Burton (Elsevier Publishing Co. Ltd., London, 1949).

MISCELLANEOUS NOTES

1. THE INDIAN MONGOOSE IN JAMAICA

According to G. S. Cansdale (ANIMALS AND MAN. Hutchinson, 1952, p. 73) the Indian Mongoose was introduced into Jamaica to deal with the rat nuisance. At first rats suffered. 'Within ten years it was obvious that a fatal mistake had been made, for the mongoose was an omnivorous predator and attacked the ground-nesting birds and water fowl as well as the snakes and lizards that were themselves good ratcatchers'.

What I had read previously was that the *fer de lance,* a deadly poisonous S. American Viper, introduced in order to frighten slaves from running away from the plantations under cover of night, became a nuisance. To deal with this trouble the mongoose was introduced. It reduced the number of snakes, but then it attacked the sugar-cane and caused immense loss.

Whichever version is correct, we cannot say with Mr. Prater (THE BOOK OF INDIAN ANIMALS, p. 72) that the mongoose 'is now well established in the West Indies to human benefit'.

PALI HILL, BANDRA,
BOMBAY 20,
March 20, 1957.

D. E. REUBEN

2. HABITS OF THE SEROW [*CAPRICORNIS SUMATRAENSIS* (BECHSTEIN)]

In THE BOOK OF INDIAN ANIMALS published by your Society, I came across the statement that 'the Serow live in the recesses of thickly wooded gorges whose boulder-strewn slopes and shallow caves give shelter from the weather'. This is very much so the case during the monsoons. In winter, and more so in summer, I have noticed that they can be found in opener forests and on gentler slopes. It is their habit to scratch a small area of ground with their hoofs as resting place on a hill-slope, under shelter of overhanging trees or fallen trunks. A number of these resting places are in evidence along a contour of a hill, possibly along the route they take for their feeding. I have also noticed that on hot airless afternoons they climb gently sloping trees and find a crotch to rest in, where gentle breezes can reach them.

One other interesting habit with which the locals credit the serow is that at times, in thick undergrowth when it suspects human approach but cannot see through the foliage, it stands up on its hind legs to get a better view of the intruder. This latter statement I have not been able to prove.

Lastly, like the nilgai and chinkara, it normally visits the same place to leave a pile of droppings.

c/o 56 A.P.O.,
July 19, 1957.

R. J. SOLOMON,
Major, 17 Rajputs

3. CEYLON'S WILPATTU NATIONAL PARK

(*With a plate*)

Few countries have received so much of nature's bounty as Ceylon. This is reflected not only in her scenery, climate and vegetation, but also in her share of the animal kingdom. The prowess of the poacher and the skill of the shikari have left their mark, however, and in common with most countries Ceylon's wild life is now found mainly within her parks and sanctuaries.

The Wilpattu National Park, which I was fortunate enough to visit in April 1956, is a counterpart to the well-known Ruhana. The Wilpattu lies on the north-west coast of the island and covers some 250 square miles of forest, *villus* (lakes both salt and fresh water) and sand-dunes. It is remote and unspoilt.

By virtue of 'being off the beaten track' and having poor roads (for Ceylon), comparatively few visitors frequent this park; an additional factor might be the somewhat primitive accommodation which cannot attract those people who are addicted to the 20th century's plumbing. But for those who enjoy the peace and quiet of the virgin forest, the Wilpattu can have few equals—anywhere.

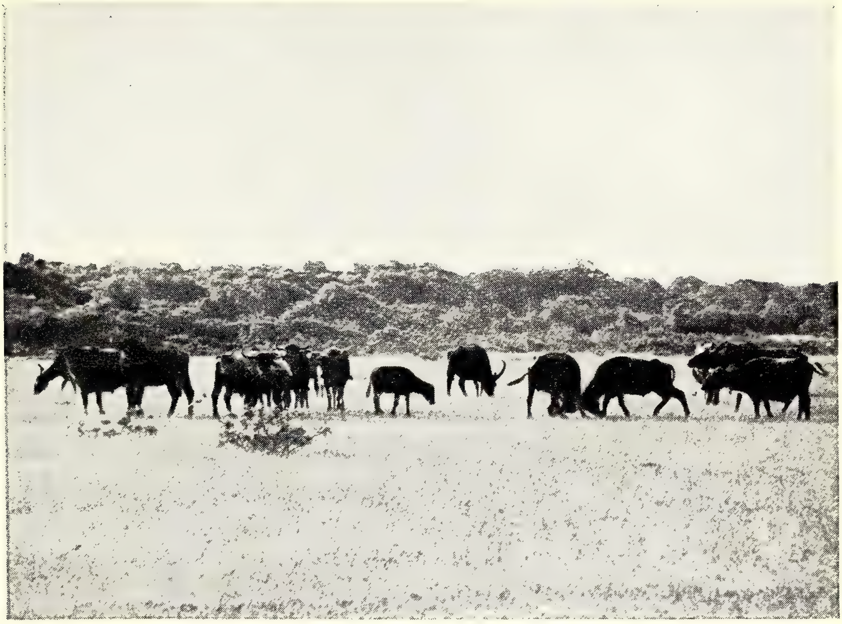
From the verandah of the rest house one can see cheetal and buffalo browsing and wallowing at the edges of a large tank in the early morning. This tank, its surface now covered with water lilies and lotus flowers, dates back many hundreds of years to when this area was once the scene of a flourishing civilization. To-day the forest is undisturbed save for the occasional visitor or forest guard.

In addition to the cheetal and buffalo found within the Park, wild elephant, sambar, barking deer, wild pig and leopard appear to be fairly numerous. Yet it is invariably the herds of spotted deer that catch one's eye; not only through their natural beauty and elegance, but also because of their large population. Leopards at present maintain a curb on their prolificacy, but an excessive deer population might easily become a reality here unless a vigilant watch is kept on their numbers. One has the example of the Andaman Islands as a fresh reminder.

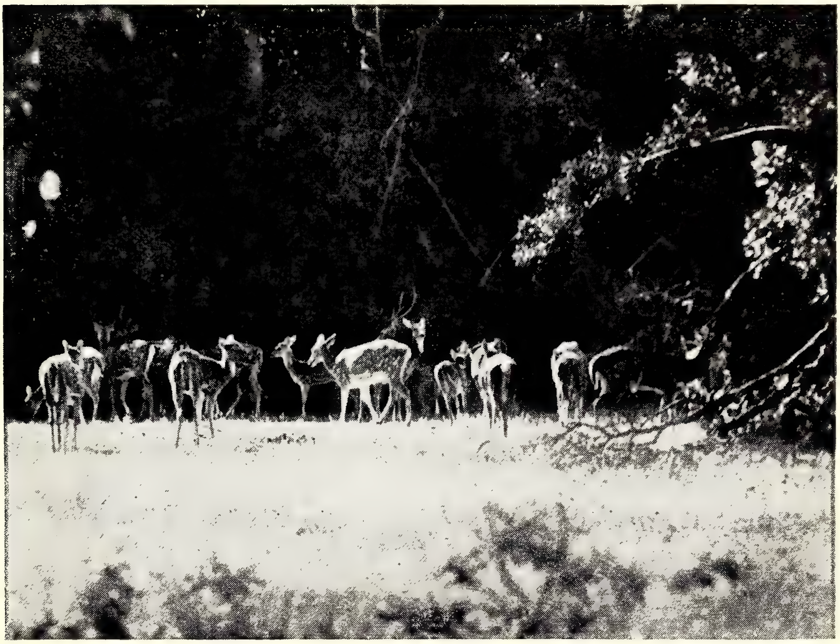
The buffalo in the Wilpattu are an unfortunate contrast to the rest of the wild life for, strictly speaking, these animals are not wild at all. From time to time, buffalo straying outside the Park are caught, broken in, and put to the plough; later, when they have served their usefulness they are released and many rejoin their former herds. This practice has naturally had an appalling affect on the stature and debility of these so-called 'wild' animals.

Apart from the constant danger of introducing such diseases as rinderpest or foot-and-mouth into the Park, it is a sad disillusionment for a visitor to see semi-domesticated animals mingling with the cheetal and the other fine inhabitants. As the already inadequate staff are not equipped to deal with this 'infiltration', there seems little chance of answering this problem in the near future. However, the scenery, especially near the lakes, does much to make up for this deficiency.

The number and variety of water birds found in the proximity of the *villus* is considerable: painted storks, duck (of many kinds),



'Wild' Buffalo in the Wilpattu Park—a typical scene in the late afternoon with a sparring match in progress.



Cheetal : one of the most abundant inhabitants of the Park.

Photos : J. H. Burnett

ibis, coots (the blue seemed particularly brilliant here) to name but a few. Inside and at the edges of the forest peafowl and junglefowl are abundant, and just as elusive to the photographer as in other sanctuaries.

The Ranger in charge of the Wilpattu, besides being obviously absorbed in his work, is also a very competent photographer. His sequence of pictures of the courtship of two sloth bears are surely unique and would make many a professional envious—if only for their quality. It was indeed refreshing to see these and other photographs taken by the Wilpattu staff on the walls of the rest house—a testimony to their enthusiasm and patience. If only some sanctuaries in India could follow this example!

April is not, perhaps, the best month in which to visit this park for the monsoon is still fairly active. As riding elephants are virtually unknown in Ceylon, one is forced to rely on a car or preferably a Jeep for viewing and photographing the wild life. A singularly hazardous venture on occasions for the roads soon become quagmires after a monsoon shower. The introduction of a riding elephant here might well produce some startling photographs, the wild life being only accustomed to seeing man on his own feet or on four wheels!

India has undoubtably much to learn on the management of her National Parks and Sanctuaries, but it is probably equally true to apply this to Ceylon. With their similar flora and fauna, the two countries would derive mutual benefits from an exchange of views and problems, not only through official visits, but also in the pages of the *Loris* and Bombay Natural History Society's *Journal.*

TIOK TEA ESTATE,
SONARI P.O.,
ASSAM,
July 18, 1957.

J. H. BURNETT

4. A SUNBIRD'S UNUSUAL NESTING SITE

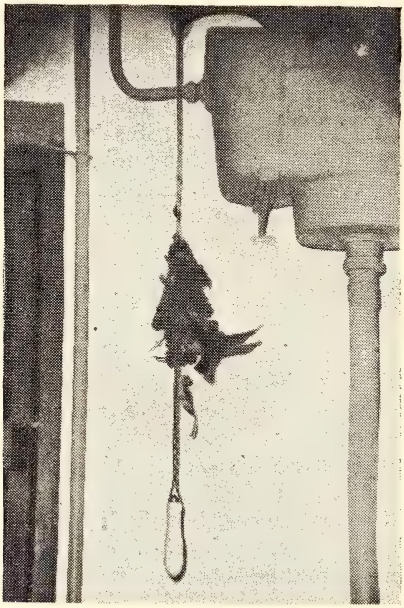
(*With a photo*)

The enclosed photograph is that of a Purple Sunbird (*Nectarinia asiatica*) that nested in my bathroom this season (April-June). It was taken by Mr. K. M. Vaid of this Institute on the morning of 20th April.

The bathroom in which the birds nested was in daily use, but the door was kept open most of the time. The door opens out to an uncovered verandah, and the inside of the bathroom is reached from the garden only by going round the door.

On the morning of April 18, 1957, at 8 a.m., while I was having a wash at the washbasin, I heard the birds behind me. I turned round and saw the pair flying away from the chain. Promptly I surrendered the room to the birds and the female began nest construction immediately. I have kept fairly detailed observations on the construction of this nest.

The first egg was laid on April 26 and the second egg on 27th. Egg (s) hatched on May 10, and one young bird was fledged on May 25. For 17 days afterwards the female bird visited the nest occasionally and kept it in order. An egg was again laid on June 12 and incubated for two days. I have not seen the birds since.



42, Trevor Road,
Forest Research Institute,
New Forest, Dehra Dun,
July 19, 1957.

JOSEPH GEORGE

5. EDIBILE-NEST SWIFTLETS IN BURMA

When preparing a note on Edible Birds'-Nests for the Government of India's publication THE WEALTH OF INDIA in 1944, I had received the following reply to my enquiry from the late Mr. S. F. Hopwood, I.F.S., Burma, who was then in the Inter Service Topographical Department, Rear H. Q., S.A.C., S.E.A., New Delhi. It contains information of great value which it seems desirable to put on permanent record for purposes of comparison with present and future conditions. The relevant part of the letter reads as follows:

'In the old days the "economic aspect" of collecting these nests was of some importance—over a series of years, the Government of Burma in the Forest Department obtained a total of over five lakh rupees from the sale of the right to collect the nests (the same well-known Chinaman was always the buyer). In those days the value of the best quality "white" nests reached about eight times their weight in silver, but of late years the value of the nests, owing to the trouble in China, has been very low. The value of "black" nests was only about quarter their weight in silver in those days.

'In the Mergui Archipelago there are two species of swift which make edible nests: *Collocalia francica* which makes the "white" nests, and *Collocalia innominata* which makes the "black" nests of commerce. These species have a very wide range; from the Andamans and the islands on the W. Coast of Bassein through the Dutch East Indies to Queensland (?).

'In Mergui, the birds are believed to be absent from the islands all day, flying over the mainland and returning to the islands at night.

'There is evidence that this birds'-nest collecting is of great antiquity—Marco Polo refers to it.

'The birds are said to lay 2 eggs—they ought only to lay one (?).

'In spite of the heavy collections that have been made, there does not appear to have been any falling off in the number of the birds. In very recent years the Government of Burma instituted certain protective measures—the right to collect on certain islands not sold, etc. These protective measures are probably of little value. The purchaser of the right to collect the nests always suffered from the depredations of the Salons or Sea-gypsies (Mawken) who were in the habit of raiding the caves just when a new crop of nests became ripe for collecting. The real protective measures consist in the fact that some of the caves used by the birds are so difficult of access that even the Salons cannot climb into them. Also many of the entrances to the caves are mere fissures into which even a Salon cannot squeeze. No protective measures would appear to be necessary though if we had more knowledge regarding the habits of the numerous hawks which inhabit the islands, perhaps it would prove advisable to shoot the hawks. Taking into consideration the fact that they are swifts, their rate of flight is comparatively slow and they should prove an easy prey to the hawks. In addition to the swifts there are numerous limicole birds on the islands which may constitute the food of the hawks.

'The nests are ready for collecting in February, March and April. There are very numerous unfounded beliefs in connection with this nest-collecting. The nests are believed to have aphrodisiacal properties. Formerly they were thought to be made of seaweed but the "white" nests are formed of the inspissated saliva of the bird—the "black" nests are the same but they are mixed with large quantities of dirt and feathers.

'Sometimes a nestling is said to become stuck in the material of which the nest is made. It is supposed to be very lucky to find one of these, and the nest and nestling glued together have a high value. I think that the collectors manufacture these examples of nestling-cum-nest!

'The oil of the kanyin tree (*Dipterocarpus alatus*) is said to be poured down the throat of a dead nestling in which case the dried body of the nestling serves as the wick of a torch.

'Opium plays a large part in the lives of the Salons and they are said to cram opium down the gullet of a nestling and eat or smoke the body of the bird thus prepared.

'The "black" nests are situated near the entrances of the caves sometimes in very great numbers and the local inhabitants are said to believe that unless the "black" nests are all removed the crop of "white" nests will be a poor one.

'The "white" nests are situated at the extreme end of very long caves, as a rule high up in utter darkness, generally where there is a slight roughness of the rock—e.g. the beginning of a small stalactite. Most of the nests are found in caves in the carboniferous limestone, but some of the islands on which nests are found are granite.

'Nests are found on very few of the 600 odd islands that constitute the Mergui Archipelgo. One or two islands of the S. Moscos Group are the most northerly islands producing nests—these islands are granite, not limestone. Perhaps the best nests are found on Mali Don (Birds'-Nest Islands) and Mali Kaing both just W. of Tavoy Island. There is no water on these islands and the caves are very difficult of access. There have been many fatalities to the climbers when collecting birds' nests.

'There is a cave on Marble Isles, which lie between Kisseraing Island and Domel Island. This cave yields large quantities of nests'.

33 Pali Hill,
Bandra,
Bombay 20,
November 10, 1957.

SÁLIM ALI

6. THE GREY JUNGLEFOWL IN SALSETTE

In 1938 in 'The Birds of Bombay Island and Salsette' (*JBNHS*, 40: 379) we referred to the rarity of the Grey Junglefowl (*Gallus sonnerati* Temminck) in Salsette, and could then cite only two definite records of its occurrence.

In May 1950, in collaboration with the Director of Parks and Gardens, Government of Bombay, three cocks and 15 hens were purchased from a dealer in Bombay and, after banding with aluminium poultry rings, released in the Kanheri (now Krishnagiri) National Park near Borivli.

It is interesting and gratifying to note that on the many subsequent trips to that area, I have almost invariably heard or seen this bird which appears to have established itself in the neighbouring hills. Though there is no direct evidence, their presence in fair numbers after seven years indicates that they have no doubt bred here.

Initial attempts at the introduction of peafowl and cheetal have not been so successful, but with the assistance of the Milk Commissioner, by whom the Park is now administered, we hope to continue the efforts.

Messrs. Faiz & Co.,
75, Abdul Rehman Street,
Bombay-3,
August 23, 1957.

HUMAYUN ABDULALI

7. REDNECKED PHALAROPE, *LOBIPES LOBATUS* (LINNAEUS), IN SOUTHEAST ASIA

The note in your issue of April 1957 is an important addition to our scanty knowledge of the migrations and winterings of this species. In recent years we have been able, by extended native collecting and observation, (see B. E. Smythies' new 'Checklist of Borneo Birds', *Sarawak Museum Journal* VII: 9, 1957) to prove that phalaropes pass through Borneo on southern passage in large numbers. Indeed in the Kelabit uplands of the far interior, above 3,000 ft., the boys best learn to use their blowpipes on these remarkably tame birds in transit (see *Nature*, 166, 4210, 1950). In recent years I have also had naval vessels in the South China Sea, Celebes and Java seas reporting on birds seen, including many phalaropes between October and December.

But very little is known about the actual wintering grounds or the return passage. The bird is uniquely distinctive among waders in that it freely and frequently rests and swims upon the surface of the waters (salt and fresh). I have seen it do so even in the rapids of Borneo rivers. It is thus easily identified and reported by the humblest would-be ornithologist and is therefore particularly suitable for an attempt at some sort of more extended and international observation in the whole area. Efforts in this direction in South-East Asia are long overdue, and work on such lines has proved very fruitful in Europe, Africa and America.

SARAWAK MUSEUM,
KUCHING, SARAWAK, TOM HARRISSON
October 28, 1957.

[A second specimen of the Rednecked Phalarope, a solitary individual, was obtained by R. S. Dharmakumarsinhji, on 20th September 1957 near Maliya, off the Little Rann of Kutch.—EDS.]

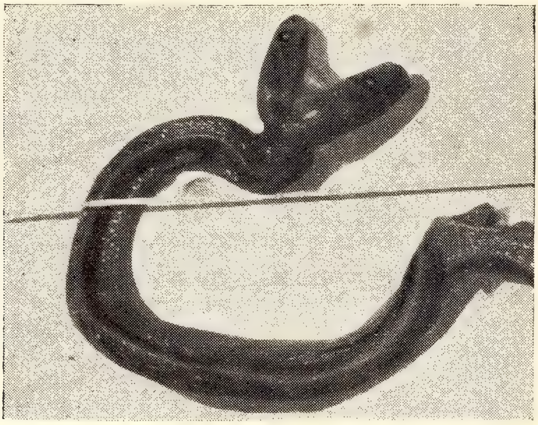
8. A DOUBLE-HEADED KRAIT, *BUNGARUS CAERULEUS* (SCHNEIDER)

(*With a photo*)

So far about 140 double-headed snakes have been recorded from all over the world including four from India. Dobson (1) was the first to record, from India, two double-headed snakes, *Lycodon aulicus* (Linn.) and *Naja tripudians* Merr. Later Wall (2) gave a good account of such abnormality in the case of a juvenile *Lycodon aulicus*. Recently Acharji (3) has described a double-headed *Vipera russellii*.

The specimen of *Bungarus caeruleus* is a new addition to the list and represents the fourth species from India.

This snake was found in Lakhaoti, District Bulandshahar of Uttar Pradesh. Due to fear of snakes among the folk, it was beaten to death with sticks, thereby breaking the body into two pieces and badly mutilating it. However, the head region escaped injury and its peculiar nature caught the attention of the senior author who obtained and presented the specimen to the College Museum.



The specimen is a juvenile measuring only 260 mm. in length, as compared to adults the maximum size of which is stated to be 4½ ft. by Boulenger (4). The two heads are joined with each other at the neck region and consequently the trunk is not bifurcated.

Our specimen resembles very much the one described by Acharji as regards the degree of bifurcation. Barbour (5) has given a photograph (Fig. 51, opposite page 50) of the common Eastern King Snake, *Ophibolus getuleus*, with two heads and separate necks joined to a common trunk. In our specimen both the heads have a common neck.

Due to the fragile condition of the snake, anatomical investigations could not be undertaken; nor could X-ray photographs be made owing to lack of facilities.

We are grateful to Mr. M. N. Acharji of Zoological Survey of India, Calcutta, for his valuable suggestions and help in this note.

EWING CHRISTIAN COLLEGE,
ALLAHABAD,
September 11, 1957.

V. R. JHA
P. D. GUPTA

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2. Wall, F, (1905): *JBNHS*, **16**: 388 & 752-753.
3. Acharji, M. N. (1945): *JBHNS*, **46**: 611-613.
4. Boulenger, G. A. (1890): Reptilia and Batrachia in Fauna of British India series.
5. Barbour, T. (? 1926): Reptiles & Amphibians, George G. Harrap & Co. Ltd., London.

9. A JUMPING SNAKE

Reading the notes by Mr. D. E. Reuben on 'Jumping Snakes' in the *JBNHS* of April 1956, and Mr. H. A. N. Medd in the December issue, brought to my mind the only experience I had of a snake jumping, which I think must have happened about 1927.

It was reported to me that a large Dhaman or Rat-snake, *Ptyas mucosus* (Linnaeus), had entered one of the bathrooms. This large and spacious bathroom contained among other things an old fashioned wash-hand-stand (4′ × 2′ 6″), on which were jug and basin, tooth glass and glass carafe, soap dish and many other articles.

I found a large Dhaman about 6 ft. in length, curled in amongst the articles on the stand. Having armed myself with a steel-centred, rhinoceros hide walking stick, (useless as a walking stick but an excellent weapon for snakes) I approached the stand. The snake reached out its head to one side, about a foot from the edge. I stepped forward and made a swipe at it; it was too quick for me and withdrew its head. The whole of the body was on the top of the stand. After a pause the snake again put its head out as before. This time I was determined not to make a mistake.

Lunging forward I again struck. This time not only did it withdraw its head, but it jumped completely off the stand in one motion and landed at my feet as I sprang back. Of course, on the ground one stroke with my rhinoceros hide weapon nearly cut the snake into two bits. It must have landed about 3 or 4 ft. from the stand, clearing the jug and basin, at least 11 to 12 inches in height.

BIRDPUR ESTATE,
DIST. BASTI, U.P., J. H. H. PEPPÉ
October 16, 1957.

[V. K. Chari (*JBNHS*, Vol. 49, No. 3, p. 561) reports a Dhaman 'jumping' from the branch of a tree 18 ft. above ground when disturbed.—EDS.]

10. ADDITIONS TO THE FISH FAUNA OF THE CHILKA LAKE[1]

(*With a text map*)

A systematic survey of the fish fauna of the Chilka Lake was undertaken by the Zoological Survey of India during the year 1914 to 1918. The complete list of them numbering 118 has been given by Hora (1) (1923). Later on Koumans (1941) (2) described one species of Gobiid fish from the lake. Mitra (3) (1946) recorded seven species of commercial importance from the lake and suggested plans for their fishery development. Devasundaram (4) (1954) listed 68 forms of which 40 were common ones. Subsequently Jones and Sujansinghani (1954) (5) presented 25 unrecorded species.

The present authors while studying the fisheries position of the lake during 1953 to 1956 came across the following 14 species which have not yet been recorded from the lake. To assess the importance of each of these new records, information on their frequency, season of occurrence and mode of catch was noted and this is given under each species.

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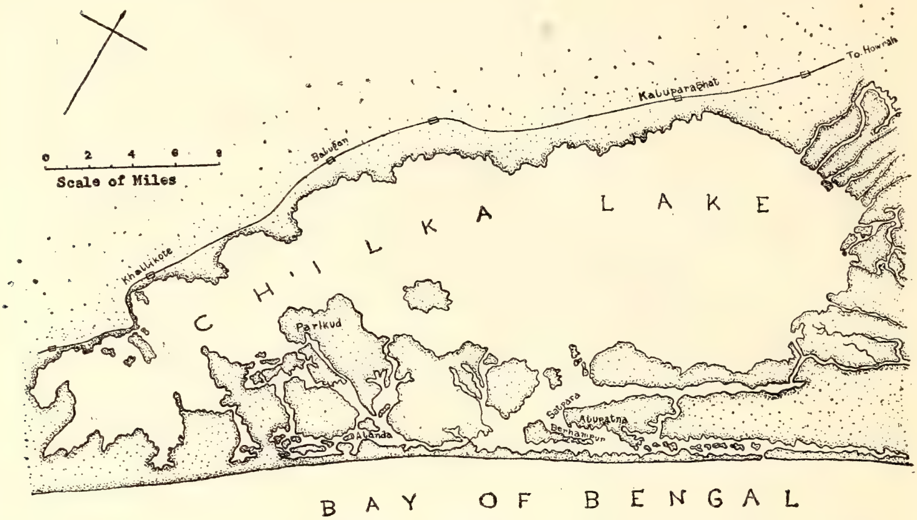
[1] Published with the kind permission of the Director of Fisheries, Orissa.



The Chilka Lake

CLUPEIDAE

1. **Hilsa kanagurta** (Bleeker)

Local name: *Keli Pila* or *Panda Pila*

This fish was found in the catches of Satpara area in the months of July and August from *Khadi jal* (drag net) and gill net operations. Strictly speaking these nets are operated to catch mullets and Hilsa. However, stray occurrences of *H. kanagurta* 10 cm. in average size were found in the catches of these nets.

CYPRINIDAE

2. **Esomus danricus** (Hamilton)

Local name: *Mohurali*

This fish was observed in the catches of shore areas near about the mouths of rivulets on the western side of the lake. But on one occasion it was found in the catches off Berhampur coast in the month of September when the salinity of the area was 6.5 per thousand.

The average size range of the specimens in the catch was 34 to 40 mm. and its fishery is negligible.

3. **Cirrhina mrigala** (Hamilton)

Local name: *Mirkali.*

This fish was caught along Balugan shore during October to January by *Patua jal* (seine net) when it was operated to catch

Engraulids. But its catch was poor and the average size of the specimens was 20 cm.

This is a freshwater fish migrating to the lake through freshets during rainy season.

COBITIDAE

4. **Lepidocephalus guntea** (Hamilton)

Local name: *Jhimkardi* or *Jhilari*

It was caught during winter months by *Patua jal* along Balugan coast. The average size in which it was caught was 7.5 cm. The catch was insignificant and rare.

SCHILBEIDAE

5. **Silonia silondia** (Hamilton)

Local name: *Ardi.*

This fish was found among the catches of *Patua jal* along Balugan and Kaluparaghat shore during the months of September to December. The average size was about 14 to 15 cm.

PERCIDAE

6. **Pristipoma argenteum** (Forskal)

Local name: *Kokarba.*

Though caught along with other perches in *jans* (enclosure fishery) and *by Khadi jal* during winter months, it was not very common. Stray catch of this fish was also observed near about Khallikote. The average size varied from 20 to 25 cm. Due to its poor catch, it is included with *Khuranti* with which it has external resemblance.

CARANGIDAE

7. **Megalaspis cordyla** (Linnaeus)

Local name: *Thumburda.*

This fish was observed in the catches of *Khadi jal* and *Patua jal* operations in Parikud and Satpara areas in the months of June to September along with other varieties such as *Gerres*, Perches etc. The average size of the fish caught was 40 cm. It forms a minor fishery of the lake and has low market value.

8. **Chorinemus sancti-petri** Cuv. & Val.

Local name: *Khadisa* or *Parei.*

This fish was observed in the catches of *Khadi jal* in the Outer channel and near about Satpara. From the *jans* around Alanda its catch was also reported. The size of the fish ranged from 25 to 30 cm. and it forms a minor fishery.

LUTIANIDAE

9. **Lutjanus russelli** (Bleeker)

Local name: *Samudra Gahan.*

This species was caught from Alupatna-Satpara area by *Khadi jal* during the period May to August. The catch was rare and the average size of the fish in catch was 15 cm.

SPARIDAE

10. **Crenidens indicus** Day

Local name: *Dhala Khuranti.*

It was caught mostly by *Khadi jal* and in *jans* from November to February. The average size in the catch was 18 cm. This fish is common in Parikud and Satpara areas.

11. **Chrysophrys datnia** (Hamilton)

Local name: *Kala Khuranti.*

This fish was caught mostly in *jans* and in *Khadi jal* operation during November to February at an average size of 20 to 30 cm. *C. datnia* is taken in fair numbers from the lake and has high market value. In the local market it is sold both in fresh and salted condition.

SCATOPHAGIDAE

12. **Scatophagus argus** (Bloch)

Local name. *Kara Chandi* or *Pita Chandi.*

This fish was found among the small-sized miscellaneous fishes caught in *Khadi jal* and *Patua jal.* Observations on the Balugan coast showed this fish to be available throughout the year. The average size was 10 cm. but the quantity of catch was poor.

SCOMBRIDAE

13. **Echeneis naucratus** (Linnaeus)

Local name: *Magar Joka.*

It was almost always seen attached to the body of sharks and was generally caught in the outer channel. During summer, 1955 stray catches of it were made in the Balugan coast. The average size range was from 40 to 50 cm.

This fish is consumed by the poor people and its market value is very low.

ANABANTIDAE

14. **Colisa lalius** (Hamilton)

Local name: *Chandi Kou* or *Raja Kou.*

It was seen in the catches of Kaluparaghat area by *Patua jal* operation in the rainy season. During that period it was caught along Balugan coast also. The average size was 5 cm. only.

It forms a very poor fishery in the lake and is sold in the local market along with *Thrissocles* sp. and Anchovies.

CHILKA BIOLOGICAL STATION,
BALUGAN,
ORISSA,
May 20, 1957.

J. C. ROY
N. SAHOO

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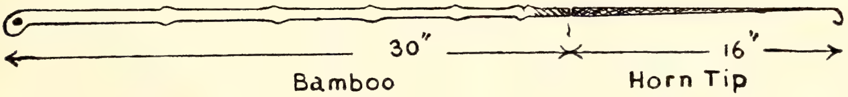
11. AN INDIGENOUS FISHING ROD AND TACKLE

(*With a text figure*)

By courtesy of Nawab F. Ali Akbar of Secunderabad, I obtained some fishing rods of indigenous and unusual construction. These very short rods (about 30″ long) are made from ordinary bamboo, which has a naturally grown 'pistol grip' butt, (rootstock). To this a tip of about 16″ length is fixed by (?) means of a blacksheet sleeve. The particularity is that this tip is made from buffalo horn, tapered down from about 5/16th to 1/32nd of an inch at the tip. To this tip is tied a small loop of red silk (or cotton?) thread to serve as the 'end ring'. Such horn tips are entirely hand-made with a knife, and I am told that it takes several days for a skilled hand to produce one. The horn tip tapered down to such a small diameter is exceptionally pliant and sensitive (antenna-like) and indicates the slightest nibble of a fish. It makes the use of a float superfluous.



This outfit, I am informed, is the standard tackle of anglers in Hyderabad. Fish of 50 lb. and over are being taken on it from the local tanks. The method of fishing is shortly described as follows:

The line, kept on a wooden reel (similar to those used for flying kites) runs through a small hole, drilled through the butt end of the rod and then through the silk loop at the tip. The baited line is kept rather tight. The horntip indicates the most cautious and gentle bite distinctly. After the strike the rod is released immediately and is taken out by the out-running fish, which is then played from the reel only; the rod is ultimately recovered after landing the fish. Though I have not tried out this rod, I am pretty sure that for cautious fish such as catla and mrigal, this method of fishing is superior to the Bengali type with a peacock quill float as generally adopted for tank fishing in India.

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* Not consulted in original.

BOMBAY PRESIDENCY ANGLING ASSOCIATION,
September 19, 1957. F. R. GOLDSCHMIDT

12. ON A NEW CATERPILLAR PEST OF SCREWPINES: *LYCAUGESIA LONGIPALPIS* SWINH. (LEPIDOPTERA: AGROTIDAE)

(*With a text figure*)

Besides the hispid *Agonia fuscipes* Baly already recorded (Nair 1956), a new caterpillar pest, *Lycaugesia longipalpis* Swinh., has been observed attacking screwpine (*Pandanus tectorius* Sol.) in Kerala. The pest has been collected on screwpine at Vellayani, Kottayam and Alleppey. At Vellayani this caterpillar attacks the host plant throughout the year.

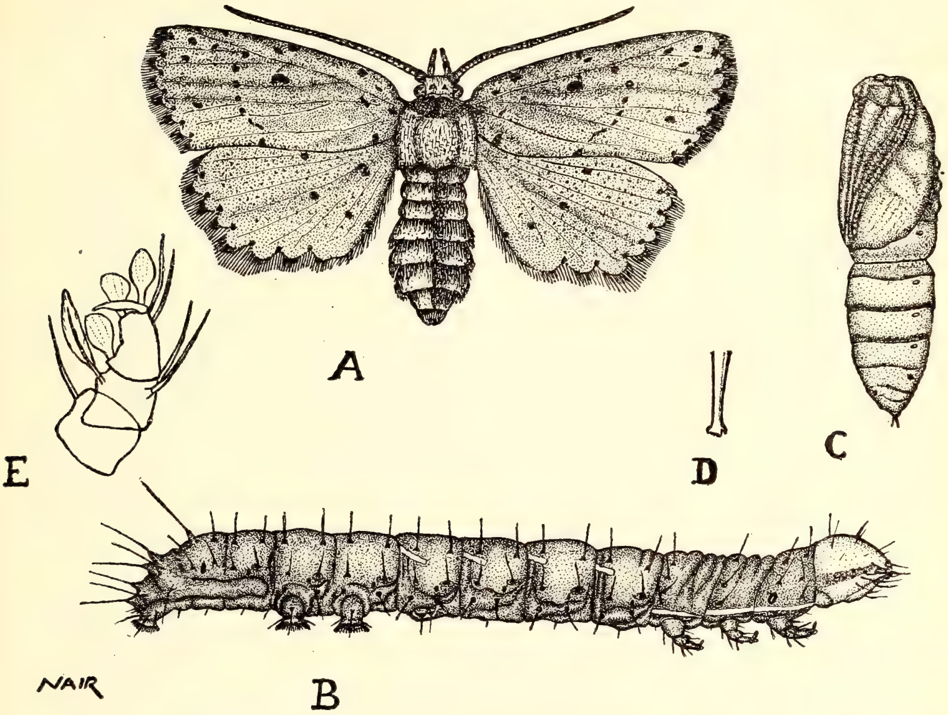
Following are the observations made on the life-history and habits of the pest.

The Egg: Eggs are laid singly on leaves. When laid the egg is pale green in colour and turns reddish brown in two days due to the developing larva inside. The egg is hemispherical, about 0.6 mm. in diameter and 0.4 mm. in height. It is radially ribbed some of the ribs being bifurcated. The ribs start from the periphery of a small circular plane space on the top pole of the egg. Ventral surface is flat and smooth. Chorion is punctate, irregularly on the dorsal pole and in regular transverse rows of pits on the sides. Egg hatches out in five days in January.

The Larva: (Fig. 1, B). Newly hatched caterpillar is a semilooper, 2.5 to 3.5 mm. long with a slender reddish brown body and light brown massive head. The body bears long white shiny hairs carried on black tubercles. Hairs borne on the two posterior body segments are as long as $\frac{1}{2}$ to $\frac{3}{4}$ the length of the body.

Laboratory rearings show that in January-February the larva passes through nine instars undergoing eight ecdyses. The first six instars are of three days duration each, the 7th, 8th and 9th instars being of 4, 8 and 7 days respectively. The total larval duration is thus 37 days. Excepting in size the different larval instars do not differ much in external morphological characters. Description of a full grown larva is given below.

Measuring 25 × 3.5 mm., the full-grown caterpillar has a semilooper gait. Body reddish brown, the colour being deeper towards the two ends; head light yellowish brown with a sharp violet longitudinal streak laterally, arising from the base of the antenna; a short white narrow streak present just above the thoracic legs, those above the first and second legs being continuous; similar white streaks each about 1 mm. long present a pair each dorsolaterally in the posterior half of the abdominal somites 1 to 4; thoracic legs black. Head, legs, pseudolegs and somites sparsely clothed with white hairs; hairs on somites borne on black tubercles; tubercles of 8th, 9th and 10th abdominal segments surmounted on drawnout fleshy papillae; hairs arising from these papillae considerably longer than the rest. Thoracic legs with three transparent scaly structures shaped like ping-pong rackets and one or two lanceolate hairs (Fig. 1, E). Pseudolegs present on 5th, 6th and 10th abdominal segments; on 4th segment pseudoleg represented by a pair of conical fleshy outgrowths surmounted by tubercles and hairs; chrochets arranged in uniordinal mesoseries.



Text fig. A. *Lycaugesia longipalpis* Swinh., adult × *c.* 2
B. Do. caterpillar × 4
C. Do. pupa × *c.* 3
D. Cremaster of pupa × 44
E. Thoracic leg of caterpillar × 28

Feeding habits of the larva and damage caused: The caterpillar during its first five instars scrapes the green matter from screwpine leaves, the later instars eating large holes in them. Usually tender leaves are preferred for feeding which takes place mostly at night. During daytime the caterpillar hides in the leaf axils or between unopened leaves. Attacked plants are easily recognised by the large holes and the greenish excrementitious matter present on the central leaves.

The Pupa: (Fig. 1, C). The full-grown caterpillar constructs a translucent web in the hollow of the leaf, rests under it for two days and then transforms into pupa. The pupa, 13 × 3 mm., is deep brown, approximately rounded anteriorly and tapering to a point posteriorly. There is a slight constriction near the posterior margin of the 3rd abdominal segment. Posteriorly are borne two pin-shaped cremasters each 0.26 mm. long (Fig. 1, D). Pupal period is 17 days in February.

The Adult: (Fig. 1, A). The adult is a medium sized moth, 25 to 30 mm. in wing expanse. It is of uniform cork colour, spotted with black. Forewing with five small black spots along costal, seven along outer and two along inner margins; a conspicuous black mark present at apex of cell, a smaller one at the base and three arranged triangularly in between; an indistinct line of black markings present post-medially the inner end of which is curved based; two black markings present near the apex; underside smoky black. Hindwing with seven black spots marginally and four medially; suffused with minute black spots; underside fuscous in the costal and apical regions and with a black spot at the apical end of the cell. The moth when at rest remains with both wings stretched. It is never seen during the daytime and is probably nocturnal in habit.

Economic Status: In the Vellayani region almost all the screwpine plants are attacked by the pest. Leaves damaged by the caterpillar are totally unfit for making mats, baskets, hats and fancy articles for which purpose screwpine leaves are used widely. In view of the damage caused to the leaves, *L. longipalpis* may be counted as a major pest of screwpines.

Grateful thanks are due to Dr. A. P. Kapoor of the Zoological Survey of India, Calcutta, for the identification of the moth and to Messrs. M. C. Cherian, Principal, and K. V. Joseph, Entomologist, Agricultural College, Vellayani, for helpful suggestions and facilities provided.

ENTOMOLOGY DEPT.,
AGRICULTURAL COLLEGE,
VELLAYANI, KERALA,
June 16, 1957.

M. R. G. K. NAIR

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13. EGG-LAYING OF THE DRAGONFLY *INDOPHAEA CARDINALIS* (FRASER) [ODONATA : INSECTA]

While sitting beside a small mountain stream in the Ashambu Hills (the extreme south of the Western Ghats) I noticed two dragonflies (*Indophaea cardinalis*) which had paired. This species is common in these parts, the male having the apical half of the hindwing tipped bright red underneath, and bluish black on top, while the female has clear wings. The length of the wings is about 1½ inches. Both dragonflies alighted on a stick, part of which was submerged. The male was well above water level and the female had its abdomen in the water. Suddenly the female went right into the water. (Later I observed it went in abdomen first, and then, when only the wing tips were above water, it turned round and went further down the stick, head first.)

The water was running very strongly round the stick and rocks and I could not see the dragonfly until I changed my observation post. It remained under water for 1 hour 7 minutes, during which time the tips of the wings may have come above the water once, but bubbles and the strongly running water made observation difficult. While the female was under water the male remained on a rock nearby and chased away two other males of the same species which were the only ones to come near.

When the female came out on to the upper part of the stick the male at once came and rested on a rock very close to it, and after 5 minutes came over to the female, which immediately went into the water at the same place, and this time stayed under for 1 hour 50 minutes, though after the first 40 minutes the tips of its wings often came above the surface. Ten minutes before completely emerging, the dragonfly rested with its head above water, eyes awash.

As soon as the female finally came out the male flew over at once and both fluttered down the river. Though remaining for such a long time under water, the female only laid eggs on a length of the stick of about two inches, all round a diameter of about half an inch.

DOHNAVUR FELLOWSHIP,
DOHNAVUR,
TIRUNELVELI DISTRICT,
SOUTH INDIA,
October 17, 1957.

(MISS) EVELYN BOWDEN

14. NOTE ON A HUNTING WASP, *NOTOGONIA JACULATRIX* (SMITH)

N. jaculatrix is an entirely black wasp about 12 mm. long. It can be seen darting rapidly about on the ground, searching for the crickets on which it preys. The antennae seems to give it an indication of the presence of a cricket, for it then betrays much excitement, pulling away small stones and digging loose earth in order to uncover the victim. It is difficult to distinguish the exact method of capture, as there is a violent scuffle. The cricket is stung more than once; the wasp then retires a few inches away in order to clean itself up, especially the antennae, after the struggle. I have seen the prey carried flying, and also dragged along the ground, in both cases head first. A captured cricket measured 15 mm.

The three nests I have seen were on a bare hill-side near a bush on Sinhagad; in a small clearing in forest at Lonavla; and a third between Shahabad stones of a verandah floor. They are tunnels in the ground, about 5 inches deep in the only one I dug up. Stones and bits of earth are pulled up backwards with the mandibles, dust kicked out by the front legs.

The wasp takes down its prey at once without leaving it at the top while it examines the nest, as many wasps are said to do. After pulling down the cricket, it took down some small stones, sticks and bits of grass, before filling up the tunnel with earth. Perhaps this was to make a small chamber for the grub, as the earth here was loose and dusty. In the forest nest where the ground consisted of coarse bits of earth, about 50 bits were taken down one by one. Then the wasp kicked dust into the hole and finally coarse lumps were used to fill it up to ground level. It spent much time putting everything to look undisturbed over the top. In the one nest I dug up, the white sausage-shaped egg, about 2.5 mm. long, was laid crossways on the thorax of the cricket, just under the coxae of the anterior legs.

Panch Howd,
Poona 2,
September 20, 1957.

F. L. WAIN, S.S.J.E.

15. NOTES ON THREE COMMON TREE-HOPPERS (MEMBRACIDAE: HEMIPTERA) IN ORISSA

Otinotus oneratus Walk. This is one of the most widely distributed membracids in India infesting as many as 35 different species of plants belonging to 21 families in Bihar, Bengal and Orissa (Behura, 1951; Behura and Sinha, 1951; Panda and Behura, 1956). Four additional host-plants of *O. oneratus* are now recorded from Orissa (Table).

Leptocentrus taurus Fabr. This is a widely distributed membracid of India occurring also in Sikkim, Burma, Singapore, and Timor as well (Distant, 1907, 1916). The authors observed this species as being common in the districts of Balasore and Cuttack in Orissa. *L. taurus* is more common during the summer and the monsoon months than in winter. Generally, *L. taurus* is solitary, but is sometimes seen in groups of 2 to 5. Its body is more pigmented and punctate than that of *O. oneratus*. Probably because of this deeply pigmented nature of the body and consequently its greater capacity for absorbing solar energy, *L. taurus* is more active than *O. oneratus*. The former flies away at the slightest provocation to the higher twigs of the host-plants, whereas the latter keeps on moving round the stem, thus trying to evade the approaching enemy, and flies away only when badly disturbed. The adults of *L. taurus* sit on the twigs with their heads pointed upward or downward. They are generally found sucking sap near the axils of the leaves or small twigs.

The body of the nymphs is compressed and elongated. They are green in colour and remarkably resemble the tender parts of the host-plants. One often misses them unless one follows the path of an attending ant. The newly hatched imago is greenish like the nymph but gradually changes to black after some time. There is some variation in the coloration of the eyes of the adults. In some the eye colour is dull ochraceous and in others reddish. They are usually found attended by the common ant *Camponotus* (*Tanaemyrmex*) *compressus* Latr. A list of the additional host-plants of *L. taurus* not hitherto recorded (Lefroy, 1909; Sengupta and Behura, 1957) is given in the table.

Another species of membracid *L. substitutus* Walk. occasionally occurs along with *L. taurus* on the host-plants.

Oxyrhachis tarandus Fabr. This species is widely distributed in India and also occurs in Egypt and South Africa (Distant, 1907). The brown colour of the adult with the posterior pronotal process curved up from the apex of the wings is remarkable in simulating thorns and dried up twigs of the host-plants. They live in droves sometimes in large numbers and are usually attended by the ant *C. compressus.*

A list of the additional host-plants of *O. tarandus* not hitherto recorded (Distant, 1907; Lefroy, 1909; Fletcher, 1920; Sengupta and Behura, 1957) is given in the table.

The present work is based on observations made by the authors intermittently during 1952-1957.

ACKNOWLEDGEMENTS

Thanks are due to Shri H. Patnaik of the Department of Botany, Ravenshaw College, Cuttack for the identification of a few host-plants recorded here, and to the Director, Zoological Survey of India for the loan of identified membracid material for comparison with the specimens collected. The authors are also indebted to the Board of Scientific and Industrial Research, Orissa and the Utkal University for generous research grants enabling this study.

DEPARTMENT OF ZOOLOGY,
RAVENSHAW COLLEGE,
CUTTACK
May 23, 1957.

UPENDRA CHANDRA PANDA
BASANTA KUMAR BEHURA

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TABLE

Hitherto unrecorded host-plants of the three species of membracids in Orissa

Scientific name of plant	Family	Local popular name current in Orissa	Locality	Period of infestation as observed by the authors
1. Otinotus oneratus Walk.				
Entada scandens Benth. ...	Mimosaceae	Gila	Dadpur (Cuttack Dist.)	March
Impatiens balsamina L. ..	Balsaminaceae	Haragoura	Balasore	August—September
Ocimum sanctum L. ..	Labiatae	Tulashi	Sudhakanthy (Cuttack Dist.)	March
Vigna catjang Endl. ...	Papilionaceae	Baragudi	Sudhakanthy (Cuttack Dist.)	March
2. Leptocentrus taurus Fabr.				
Aegle marmelos Correa ...	Rutaceae	Bela	Naradia (Cuttack Dist.)	Summer months
Anona squamosa L. ...	Anonaceae	Ata	Balasore	Rainyseason
Cajanus indicus Spreng, ...	Papilionaceae	Harada	Balasore	Summer months
Calotropis gigantea Br. ...	Asclepidaceae	Arka, Arakha	Cuttack	December
Ficus bengalensis L. ...	Moraceae	Bara	Balasore, some places of Cuttack District and Khurdha (Puri Dist.)	May to August
Helianthus annus L. ...	Compositae	Suryamukhi	Cuttack	September
Leptadenia reticulata W. and A....	Asclepidaceae	...	Cuttack	December
Morinda tinctoria Roxb. ...	Rubiaceae	Acchhu	Jagamara (Puri Dist.)	May
			Naradia (Cutack Dist.)	Rainy season
Spondias mangifera Willd. ...	Anacardiaceae	Ambada	Balasore	August
Tectona grandis L. ...	Verbenaceae	Saguan	Balasore	Rainy season (upto August)
Vitex negundo L. ...	Verbenaceae	Begunia	Balasore	August
3. Oxyrhachis tarandus Fabr.				
Acacia leucophlaea Willd. ...	Mimosaceae	Gohira, Gulura	Meramandali (Dhenkanal Dist.)	January
Albizzia lebbek Benth. ...	Mimosaceae	Sirisha	Naradia (Cuttack Dist.)	Winter months
Cassia fistula L. ...	Caesalpiniaceae	Sonari	Balasore	August
Pithecolobium dulce Benth. ...	Mimosaceae	Belati kaiyan	Cuttack	Winter months

16. HOMERIC BATTLES ON THE DINNER TABLE

In the years 1892-1894 we subalterns used sometimes to have the table cleared after dinner. Beneath an inverted glass finger-bowl would be introduced a scorpion and a 'jerrimundlum'—a spider-like animal (*Galeodes* spider ?). Then we would watch the contestants as they moved around the edges of the bowl, select our favourite and each stake a bottle of beer on the result of the encounter. Effort was made to stage the battles on apparently equal terms. If the 'jerrimundlum' was thin it might be the victor, but if it had a fat body due to a recent meal, the scorpion would be the choice. Both creatures used to fence and feel with their thin sensory hairs. The object of the scorpion was to obtain a hold with its two small pincer-like forward pointing appendages (chelicerae). Then it would very quickly curl over its armed tail and jab the sting into the spider's body which would instantly collapse like a pricked balloon. Death was immediate, and the enemy devoured at leisure.

Through an extraordinary instinct the jerrimundlum knew the weak point in the scorpion's anatomy to be the thin neck by which the poison gland and sting is joined to the end segment of the tail. Its aim was to seize this 'neck' with its horny mandibles, which worked in four separately moving segments, and chew it off. Thus it gained the victory and resultant repast.

Many of those after-dinner entertainments were most exciting, and some fights lasted a considerable time. It did not occur to us that they were cruel, as we were but witnessing what was taking place all the time along the walls of every building. Some kept a tame mongoose which was a most efficient exterminator of spiders etc. and of rodents in all the rooms of a building, and always a most engaging pet about the house.

c/o Lloyds Bank Ltd.,
39 Piccadily,
London, W. 1,
August 19, 1957.

R. W. BURTON,
Lt.-Col., I.A. (Retd.)

17. OCCURRENCE OF *APUS* (CRUSTACEA: NOTOSTRACA) IN PILANI, RAJASTHAN

We were out for collecting water beetles (*Cybister tripunctatus asiaticus*) from tanks in the Agricultural Farm on the morning of August 10 and stopped at a 'kucha' rain water pond about 20 ft. in diameter outside the farm area. To our surprise we found here *Apus* and other freshwater Branchiopods in abundance. Evidence of the occurrence of *Apus* in Rajasthan is rather obscure and this is the first record of it from the vicinity of Pilani, the surroundings of which were barren and desolate till as late as 1946. Ever since then, thanks to the sinking of a number of tube wells and the continuous efforts of the local authorities, Pilani is becoming greener every year. The average rainfall is about 18 inches, but this year (1957) the rains are quite heavy. Rain water is either quickly drained off due to the topography or is absorbed by the sandy soil so that after a shower the soil surface is just wet and not muddy. May and June are the hottest months with an average maximum temperature of about 42.22° C. This diminishes to about 26.6° C. in the winter months, especially in January.

The pond in question was shallow with a maximum depth of three feet in the centre. The sparse vegetation surrounding it was composed mainly of *Prosopis spicigera*, *Acacia arabica*, *Zizyphus rugosa*, *Calotropis procera* and *Phyllanthus* sp. *Apus* and the other specimens collected were brought to the laboratory and kept alive in large glass jars. The manner in which *Apus* swims with its ventral side up is very interesting and the rhythmic movements of the appendages is very nice to watch. Many students had not seen a living *Apus* and hence this became an exhibit of interest for even the senior students. As it was difficult to keep the specimens alive for long in the glass jars they were preserved in 70% alcohol.

A brief account of the crustaceans obtained from the pond is as follows :

1. *Apus* (Notostraca) ...	Collected in large numbers; float with ventral side up; colour red; sizes varying from 30 to 50 mm. in length.
2. *Branchipus* (Anostraca) ...	Abundant; two forms. One giant, red in colour and 40 mm. in length; the other smaller, 15 mm. long, silvery white with caudal furci red in colour.
3. *Estheria* (Conchostraca) ...	Small, swift swimming forms, red in colour; carpace bivalved.

Besides these Branchiopods, there were many other animals in the pond, namely, mosquito larvae, larvae of water beetles, rotifers, tadpoles, etc. One noteworthy feature was the absence of *Apus* in the nearby ponds.

Big shoals of *Branchipus* were noticed in clear rain water pools in the adjacent mountainous region (Khetri). The specimens of Branchiopoda obtained from the vicinity of Pilani have been sent for identification and the morphological work on the different species is in progress.

Department of Zoology,
Birla College,
Pilani (Rajasthan),
September 5, 1957.

S. N. MATHUR
NARSINGH SIDHU

18. DESTRUCTION OF TIMBER BY MARINE ORGANISMS IN THE KARWAR PORT

(With a graph)

The observations given herein relate to the destruction caused by marine wood borers to large timber beams, exposed to the action of sea water near the mouth of the River Kali at Karwar, a minor port about 250 miles south of Bombay. The mixing of the waters of the river in the harbour area considerably affects the salinity during high and low tides and also during the different seasons of the year. It is a common practice in India to store large timber beams under such conditions for natural seasoning, but a number of them are often destroyed by shipworms or other borers, when left unattended for a long time. The North Kanara forest is one of the important timber producing areas in India and the following are some of the commercial timbers commonly stored for seasoning at Karwar.

Scientific name	Vernacular name
1. *Tectona grandis* ...	Sagwan
2. *Terminalia paniculata* ...	Kindal
3. *Terminalia tomentosa* ...	Madat
4. *Bombax malabaricum* ...	Sawar
5. *Lagerstroemia lanceolata* ...	Nana
6. *Calophyllum* spp. ...	Undi
7. *Dalbergia latifolia* ...	Shisam
8. *Mangifera indica* ...	Amba
9. *Artocarpus gomeziana* ...	Phanas
10. *Xylia xylocarpa* ...	Jamba
11. *Casuarina* spp. ...	Suru

A careful observation of the scores of timber beams spread out on the mud bank of the Kali River, enabled our making certain interesting observations on the habits of some marine organisms, actively engaged in burrowing into timber. One of the important borers, is a small isopod crustacean, *Sphaeroma terebrans* (Bates) commonly known as the Pill-Bug Borer. This creature produces an incessant noise as it bores into timber with its mandibles making innumerable pits in which it lives. The pits measure from ¼″ to about ¾″ in depth. As the animal is taken out of the burrow, it rolls into a ball. A number of these were collected for study in the laboratory. An important feature of this borer is that the female carries the young ones in a brood pouch on the abdomen and this, unlike the molluscan borers, restricts their field of movement and general distribution. On an average, each female produces about 40-50 young ones which on crawling out of the brood pouch start making new burrows in timbers, on which they may be carried with the current. These small creatures cause primary destruction to timber within a short time, thus lowering the market value of the logs due to surface spoilage. Fortunately the burrows are shallow and rarely cross each other to form long tunnels.

In many of the older timber logs, destruction by shipworms was clearly visible at their end portions where some remnants of the calcareous tubes or burrows were observed. When cut open carefully the logs were found to be severely infested by *Teredo* (*Kuphus*) *manni*, the most common species occurring in this locality as well as in Bombay, especially in the Sewri Timber Pond (Palekar and Bal, 1955).

It may be mentioned here that a shipworm measuring over $2\frac{1}{2}$ ft. in length and $\frac{3}{4}$ inch in diameter was taken from one of the timber beams.

In order to study the fluctuations in salinity at this locality, water samples were collected at high and low tides on every full-moon and new-moon days for the year June 1951 to May 1952. These two days were selected so as to obtain the maximum fluctuations in salinity during each month, and the salinity was determined by titration with silver nitrate as usual.

The erratic fluctuations in salinity during the course of the year 1951-1952 is shown in the graph. The period from June to October marks the rainy season, when the flow of fresh water from the Kali River into the inshore waters of Karwar is the greatest. This results in lowering the salinity at the river mouth to a minimum, with sudden rise on certain occasions depending on the admixture of fresh water from the river. It may be noted that during August, the influx of river water was so great that at one time during the year, the salinity was as low as 0.1 per thousand even at high tide. In June and October, the salinity was as high as 34.1 per thousand and 35.0 per thousand respectively. At the close of the rainy season, i.e. during November and December the salinity takes an upward trend varying within a range of 20.2 per thousand to 35.2 per thousand in this locality. From January to May, the salinity remains relatively steady showing small variations ranging between 30.8 per thousand and 38.4 per thousand during high and low waters.

Evidently *Sphaeroma* and *Teredo* occurring here tolerate wide fluctuations in salinity, both gradual (as low as 0.1 per thousand and as high as 38.4 per thousand, during the course of the year) as well as sudden as seen from the graph.

It may be stated here that Karwar is an ideal natural harbour with plenty of promise for its further expansion into a large port. A number of boats and country craft ply every day in the harbour area, particularly in the locality reported on above, and it is quite natural that these may help in the dispersal of borers to far off places. Hence, the need for necessary precautions to preserve timber by modern methods is very great in this fast developing port.

The above work has been carried out with funds provided by the Forest Research Institute, specially obtained from various sources for the execution of the scheme on the protection of Indian timbers against the attack of marine organisms.

WOOD PRESERVATION CENTRE (F.R.I.
DEHRA DUN),
INSTITUTE OF SCIENCE,
BOMBAY,
March 8, 1957.

V. C. PALEKAR
D. V. BAL

REFERENCE

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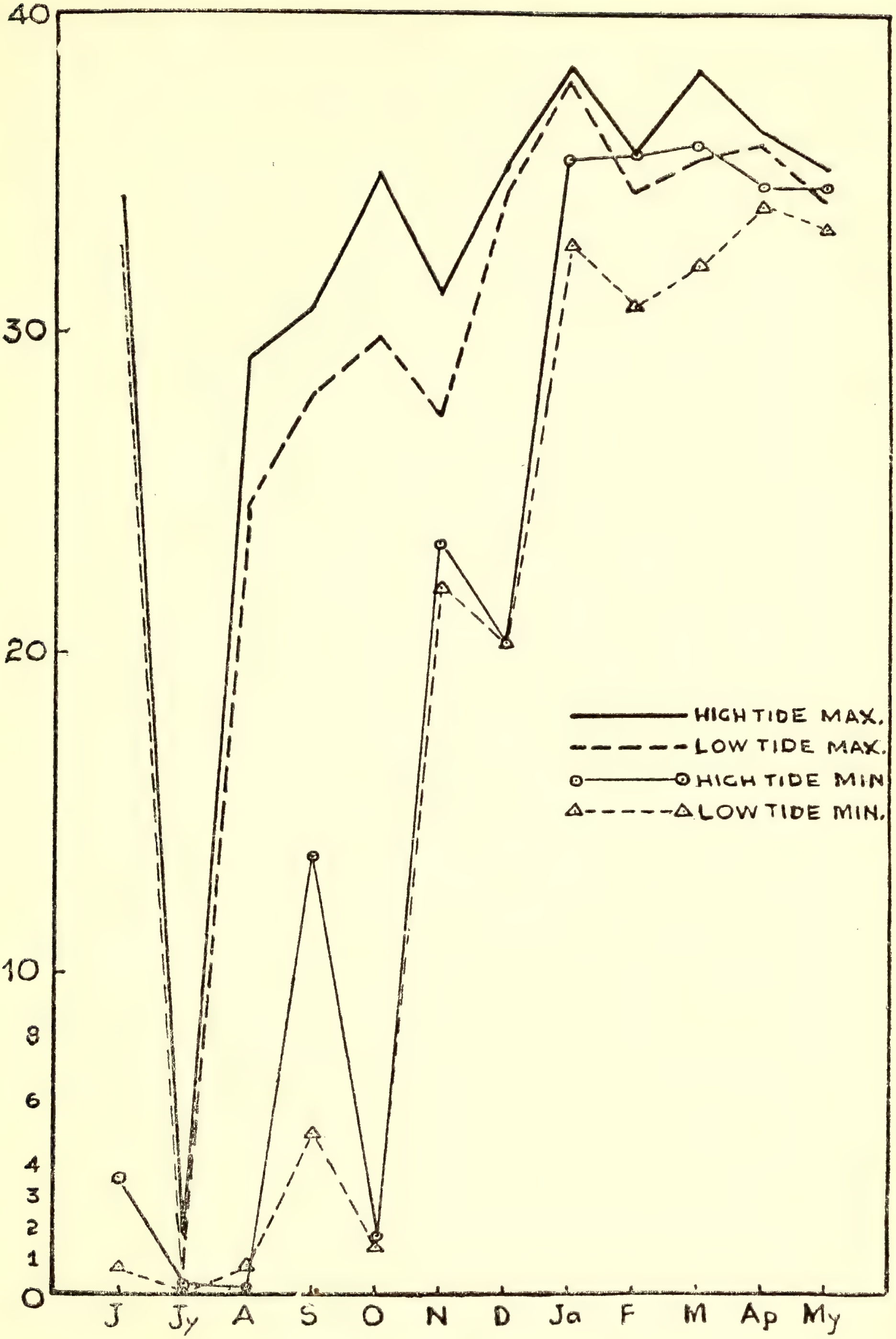

Graph showing monthly variations in salinity near the mouth of Kali River at Karwar during the year 1951–52

19. *SOLANUM ESURIALE* LINDL. A NEW RECORD FOR BOMBAY STATE

A sub-erect prickly perennial undershrub branching from the base; stem cylindrical, covered with yellowish tomentum of stellate hairs; prickles straight, 3-4 mm. long, pale brown, more conspicuous after the monsoon. Leaves 4-12 cm. long, petiolate, oblong, linear, subacute to obtuse at the apex, rounded or somewhat tapered at the base, stellately hairy on both sides (densely so beneath), slightly unequal at the base, midnerve covered with a few prickles, secondary nerves 6-7 pairs, petiole 8-15 mm. long clothed with dense stellate tomentum. Flowers in leaf opposed, 2-6-flowered corymbs; peduncles short, pedicels 10-20 mm. long, densely stellate fulvous hairy, usually with a few prickles. Calyx campanulate, 8-12 mm. long, divided about $\frac{1}{4}$ way down, lobes linear, unequal in length, clothed with densely stellate fulvous hairs. Corolla 15-18 mm. long, violet-mauve, 5-lobed, divided $\frac{3}{4}$ way down, tomentose outside with purple stellate hairs, glabrous inside, tube 1 mm. long, yellowish. Filaments 3 mm. long; anthers 5-6 mm. long, basifixed, slightly cordate at the base, opening by small apical pores. Ovary is globose ovoid, densely clothed with stellate hairs at the apex; style glabrous, 12 mm. long, dull white; stigma green, slightly bilobed. Berry 5-10 mm. diam. globose, yellowish to pale brown when ripe.

Seeds 2-3 mm. diam. discoid, brown, smoth.

From the key given for the genus *Solanum* in Cooke's flora the above mentioned species shows some affinity towards *S. indicum* L. but it differs in the following points: (i) shape and size of the leaf; (ii) proportion and structure of the prickles; (iii) length of the filaments; (iv) seeds not pitted. I have seen this plant in July 1955 near Nene Ghat along the Mutha River side, now it is spreading and getting naturalized. It grows well in waste places and on rubbish heaps about Poona. The author is very grateful to Miss Viloo M. Patel of St. Xavier's College for identifying the specimen. The author is also indebted to Rev. Father H. Santapau for going through the note and for his valuable suggestions. The plant is said to be a native of Australia.

Fls :—July-December. Frs :—September-February.

Reference Specimens:

Poona: Nene Ghat, Mutha Riverside, *Vartak* 2735, 10-12-55. *Vartak*: 4873-75, 22-6-1956; and 8533-64, 13-5-1957.

MAHARASHTRA ASSOCIATION
FOR THE CULTIVATION OF SCIENCE,
POONA 4,
July 11, 1957.

V. D. VARTAK

20. FURTHER NOTES ON THE INDIAN SPECIES OF *CURCUMA* (ZINGIBERACEAE)

On several previous occasions, in this journal (45 : 1618-624, 1945 and 51 : 135-139, 1952) and elsewhere, I have discussed the double position of the spike, central and lateral, in relation to the leaves of some species of *Curcuma*, and have shown that the position of the spike is not a matter of specific differences but of seasonal development of one and the same plant. This is directly contrary to the statements published in most of our national or provincial floras, and to the division of the genus *Curcuma* into subgenera and species by Schumann in his monograph in Engler's Pflanzenreich Vol. 20.

On August 3rd, 1957, with a party of students of this college, I went to the National Park, Borivli, and collected some specimens of *Curcuma inodora* Blatt., the only common species of the genus in the area. One specimen showed the lateral spike in a decaying condition but still attached to the parent plant; in addition there was a central spike with buds or flowers present. This definitely confirmed the suggestion I had made in the *Journal* (51 : 138, 1952) that in *Curcuma inodora* Blatt. one and the same individual plant has two types of inflorescence according to the season of the year or to the age of the plant. Up to the time of this collection, I had only seen the double spike actually present on *Curcuma pseudomontana* Grah.

However, in the course of an extensive examination of herbarium specimens from various parts of India, I came to the conclusion that this double type of spike, central and lateral, is shown by several other species of the same genus. This conclusion, however, could not be supported by any actual herbarium sheet showing the double nature of the spike; Blatter Herbarium is the only one possessing sheets showing this clearly. The explanation for this absence may be that most often when the central spike has developed sufficiently to attract the attention of collectors, the lateral one may be in a decaying condition and naturally may be removed in the trimming of the specimen for mounting. It is quite possible that where the spike is lateral, the central one may also be present in the herbarium sheets examined; but as the proper dissection would often mean the destruction or at least severe damaging of the herbarium sheet, I have not dared to perform it without the express permission of the authorities concerned.

At the end of August of this year, I again collected *Curcuma pseudomontana* Grah. in Khandala; where the lateral spikes were present, dissection showed the presence of the central one on the same plants. Further, in one instance I noted that the central spike was still completely encased by the leaf-sheaths, but the bracts of the coma were already brightly coloured deep purple, even though they were not yet exposed to light.

Our Indian species of *Curcuma* are in sore need of revision; but this cannot be done on the materials stored up in our herbaria. May I through the pages of this *Journal* appeal to Indian botanists to help in the collection of *complete* specimens? The following points should be attended to in making collections of this difficult genus :

(*a*) Specimens should be collected at the beginning, middle and end of the monsoon from about the same spot or locality. Or if the plant is not a monsoon one then collections should be made at the beginning, middle and end of the flowering season.

(*b*) Attention should be paid to the position of the spike in relation to the leaves. Even if the lateral spike is decaying, it should be preserved carefully without detaching it from the parent plant and *mounted* on the herbarium sheets.

(*c*) The nature of the underground system is to be carefully studied; it is of specific importance in this genus. Some species have long fibrous roots spreading more or less horizontally up to 30 cm. from the rhizome; at the ends of the fibrous roots there may be a set of fusiform tubers, which should also be preserved. The whole underground system should be mounted on herbarium sheets, preferably keeping it attached to the rest of the plant.

(*d*) The leaves at times may be too large for pressing and mounting; at least some of the leaves should be mounted. At the same time the number of leaves should be noted, and their sizes measured for record.

(*e*) Often it becomes very difficult to preserve specimens properly on account of the succulent nature of the plant. Good herbarium specimens may be obtained by poisoning them with conc. mercuric chloride in alcohol before pressing; or should this become impossible, at least sufficiently good specimens may be prepared for the herbarium provided the drying sheets be changed *several times each day* for at least one week after collection. Quick drying will prevent fungal or bacterial decomposition or decoloration.

(*f*) The colour of the flowers and bracts disappears in the process of drying; it should, therefore, be necessary to note such colours in detail at the time of collection when the plants are still fresh.

In due time we shall have to revise the genus *Curcuma* for the general flora of India and for other floras; but the problem will be far from an enviable one, unless our herbarium materials are abundant and complete. It is hoped that these notes may help to prepare satisfactory herbarium specimens of one of the most difficult of our Indian plant genera.

ST. XAVIER'S COLLEGE,
BOMBAY 1, H. SANTAPAU, S.J., F.N.I.
September 6, 1957.

21. THE SPECIES OF *LAGENANDRA* OF BOMBAY AND MADRAS

Cooke in his FLORA OF THE PRESIDENCY OF BOMBAY (2: 819, 1908) lists one species of *Lagenandra*, under the name of *L. toxicaria* Dalz. C. E. C. Fischer in Gamble's FLORA OF MADRAS p. 1576 lists two species, and on p. 1889 adds a third, *L. ovata* Thw., *L. toxicaria* Dalz. and *L. meeboldii* Fischer.

Fischer has split *L. toxicaria* Dalz. of the Flora of British India into two species, *ovata* and *toxicaria* proper. The grounds for this splitting seem to be mostly a question of size of the different vegetative parts. The following table shows in a simplified manner the details of the two species as conceived by Fischer:

	ovata	*toxicaria*
Cataphyll	6—13·2 in. long	2.3—5.4 in. long.
Leaves	Oblong-acuminate	Elliptic — to ovate-lanceolate.
	6—22.5 in. long	4.4—8.4 in. long.
	1.8—7.5 in. wide	1.6—3.6 in. wide.
Petiole	5.2—4.2 in. long	2.4—12 in. long.
Peduncle	5—8.4 in. long	1.2—2.3 in. long.
Spathe	narrowly turbinate	cylindric oblong.
	2—10 in. long	1.6—2.3 in. long.
	tail subulate	tail S-curved.
	tail 1.4—1.8 in. long	tail 3.4—5.4 in. long.

Cooke gives for his plant the following sizes: Leaves 6-15 × 2-5 in., petiole as long as the blade, peduncle shorter than the petiole, spathe 3-9 in. long including the tail.

Dalzell lists these details for his plant: 'Marshy plant or aquatic, 3 ft. long. . . . Leaves long-petioled, oblong, obtuse, entire, undulate, the midnerve strong and giving out slender side nerves; stipular sheaths opposite, free, acuminate, keeled with a double keel on the back, the petioles terete, very long (non-sheathing). Scapes axillary, solitary, compressed, 2-6 inches long. Spathe a little longer than the scape, flesh to olive green in colour outside, dark purple on the tube inside.'

Except for the S-curved tail of the spathe there does not seem to be any valid character on which *L. ovata* can be separated from *L. toxicaria.* But then there is considerable variation in the size of the sterile 'tail' of portion of the spathe in many plants of the family *Araceae*, the variation being present at times with the individuals of the same species.

For this reason I feel I am justified in following Hooker, Engler, etc. in fusing the Bombay plant, *L. toxicaria*, with the Ceylon one, *L. ovata.* Fischer himself writes of *L. toxicaria* 'Resembling *L. ovata* Thw. in the vegetative parts and *L. meeboldii* C. E. C. Fischer in the spathes'.

The position of *L. meeboldii* Fischer needs clarification. Engler described *Cryptocorine meeboldii* from a specimen collected by Meebold at Agalhatti, Mysore, in November 1908 (*Meebold* 9235). In the original description Engler states that the plant's 'female inflorescence is 4-5-gynous, dark purple and is separated from the male inflorescence (which is dark purple and about 4 mm. long) by a bare space 1.2 cm. long'. This means that the ovaries are but 4-5 in number, and naturally such small number will be placed forming a ring round the base of the spathe; this is the typical character of *Cryptocorine* as against the typical note of *Lagenandra*, in which the ovaries are arranged spirally round the base of the spathe (see Engler in Pfreich. 73: 227).

Unfortunately the illustration of *Crypt. meeboldii* Engler on page 242, fig. 61 A-B, represents the species with at least 25-30 ovaries arranged spirally. Obviously either the description of the species or its representation is wrong; if the diagram be taken as correct, then the plant clearly belongs to the genus *Lagenandra*, and Fischer is correct in effecting the transfer. In my opinion, however, the diagram by J. Pohl is wrong, and we must take Engler's own description as more correct, in which case the plant definitely belongs to the genus *Cryptocorine*; in this case Fischer is not justified in shifting the plant to *Lagenandra*.

The nomenclature of these two plants is, therefore, as follows :

1. **Lagenandra ovata** (Linn.) Thw. Enum. Pl. Zeyl. 334, 1864; Engler in Pfreich. 73 : 228, 1920; Blatter in Journ. Bombay Nat. Hist. Soc. 35: 18, 1931; Fischer in Gamble, Fl. Pres. Madr. 1576, 1936.

   Arum ovatum Linn. Sp. Pl. 967, 1753.

   Lagenandra toxicaria Dalz. in Hook. Journ. Bot. 4: 289, 1852; Dalz. et Gibs. Bombay Fl. 157, 1861; Hook. f. in Fl. Brit. Ind. 6 : 495, 1893; Cooke, Fl. Pres. Bombay 2: 819, 1908; Fischer in Gamble, Fl. Pres. Madras 1889, 1936.

2. **Cryptocorine meeboldii** Engler in Pfreich. 73 : 234, f. 61A (excl. fig. 61 B), 1920.

   Lagenandra meeboldii (Engl.) Fischer in Gamble, Fl. Pres. Madras 1889, 1936.

In connection with Dalzell's name *toxicaria* (meaning poisonous), it may be of interest to read the foot-note in Hook. Journ. Bot. 2 : 290: 'Mr. Law's attention, in Bombay, had been called to the same plant, for he says, in writing to Mr. Dalzell, "I had heard there was a plant which grew in abundance on the banks of a stream flowing from a sacred spring about forty miles from hence (Darwhar), and not found anywhere else in the neighbourhood, the root (rhizome) of which is a most deadly poison, and often used by the natives for that purpose, so that it has been found necessary to forbid them to gather it. The native name is *Vutsunab*, which in Wilson's Sanscrit Dictionary is said to be *Aconitum ferox*, roots of which, I had thought it possible, might have been brought from the Himalayas and planted by pilgrims; I accordingly sent for some plants, and what should it prove to be, but your new genus Lagenandra." '

ST. XAVIER'S COLLEGE,
BOMBAY,
July 24, 1957.

H. SANTAPAU, S.J.

22. *NEURACANTHUS SPHAEROSTACHYUS* DALZ.—FURTHER COMMENTS

In a previous note published in this journal (50 : 419, 1951) the senior author together with Prof. P. V. Bole of this College described *Neuracanthus sphaerostachyus* Dalz. in full and explained the apparent absence of fruits or seeds, which had been noted by previous writers.

This year we have examined a number of plants collected in various parts of Bombay and Salsette Islands; one of these specimens has been placed in Blatter Herbarium under the number *G. L. Shah*

9043. That particular specimen was a small one, about 30 cm. high, which had just finished flowering; on examining the inflorescence we noted about 9 fully formed fruits in a single 'spike'; the fruits were still green and the seeds rather imperfect and far from fully formed.

The finding of this specimen with fruits and seeds prompted us to examine large numbers of plants in the field in search of fruits. Many of the specimens collected in the area of Vehar Lake and Mahakali Caves in Salsette and on the lower hill slopes at Mumbra on the mainland along the Central Railway line, showed a variable number of fruits in each spike; most of the plants examined had fruits in various stages of maturity.

It seems to be clear, then, that this plant does certainly set seed in the usual course of development shortly after flowering. Why it was that Clarke, Cooke and others have failed to notice the fruits of this plant, is not easy to say. It is quite possible that some of the fruits do become damaged and rot away before the season is over; this point will be kept in view and further observations made in the course of the year until the coming of the next monsoon. The senior author found plenty of fruits and seeds from December to the arrival of the monsoon some years ago.

Theoretically it is difficult to explain how the plant is so successful on many of our hills, if seeds are seldom formed. On Behran's Plateau in Khandala on the Western Ghats this plant is very abundant all over the flat portion of the plateau, and this would indicate that seed production must be effected in fairly large numbers. In addition many of these plants are damaged by the firing of our hills which is such a constant feature of the Western Ghats. It is strange that in spite of the so-called reduced production of seeds and damage by fire this plant is so successful all over western India.

Our conclusion, based on actual examination of specimens in the field, is that seeds are produced in good numbers, and that further they are protected from damage by fire by the dense masses of bracts surrounding them on the parent plant. Dehiscence only takes place when the rains of the monsoon following that in which seeds have been produced, come on our hills.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
September 23, 1957.

G. L. SHAH, M.SC.
H. SANTAPAU, S.J., F.N.I.

23. ON THE OCCURRENCE OF *FRITSCHIELLA TUBEROSA* IYENG. IN PILANI (RAJASTHAN)

(*With a text figure*)

Ratnam and Joshi (1952) while pursuing the work on 'An ecological study of the vegetation nearabouts a temporary pond in Pilani', reported *Fritschiella tuberosa* Iyeng. for the first time from Pilani (Rajasthan). During all these years the alga has been observed growing on the wet exposed soil of the banks of the pond after the receding of water. It grows mixed with *Protosiphon botryoides* (Kutz.) Klebs. and *Botrydium* sp. and is sometimes difficult to separate.

Iyengar (1932) reported *Fritschiella* from the beds of drying rain water pools on moist silt at Madras and Talguppa (Mysore Province). Randhawa (1939) recorded the alga from the fields lying fallow in the Fyzabad district. Singh (1941) reported it while engaged in the investigation of the soil complex on the 'Usar' land soils of Northern India.

Fritschiella tuberosa Iyeng. belonging to family *Chaetophoraceae* is a heterotrichous form and is markedly differentiated into various systems like:

(*a*) *Prostrate system*—consists of a rounded cluster of cells buried in the damp mud of the temporary pond. The *rhizoidal system* consists of septate long hairs and constitutes the lower portion of the prostrate system.

(*b*) *Erect* or the *Projecting system* contains cells with collar-shaped chloroplasts and 2-5 pyrenoids. The same can also be called as the *photosynthetic tissue*. Randhawa (1939) described the projecting system having the *Primary main projecting system*, i.e. the *photosynthetic tissue* and the *Secondary projecting system* consisting of hairs.

The figure shows the general structure of the plant as such. The soil analysis carried on at different spots around the temporary pond is as shown in the table. The soil samples were analyzed during the month of January 1957.

The present investigation shows some marked differences from the result of the edaphic complex determining the growth of alga as reported by Singh (1941). The soil samples are blackish in colour and show the clayey texture. The moisture content varies from 9.22% to 24.70%. Carbonates are more or less negligible except for a few soil samples where it is 1.

The results of reductivity, estimated by adding H_2O_2 show the richness of exchangeable bases in soil. Nitrate is fairly well represented at all spots. The pH value in the present investigation ranges from 7.0 to 8.5 showing that the soils are alkaline in nature.

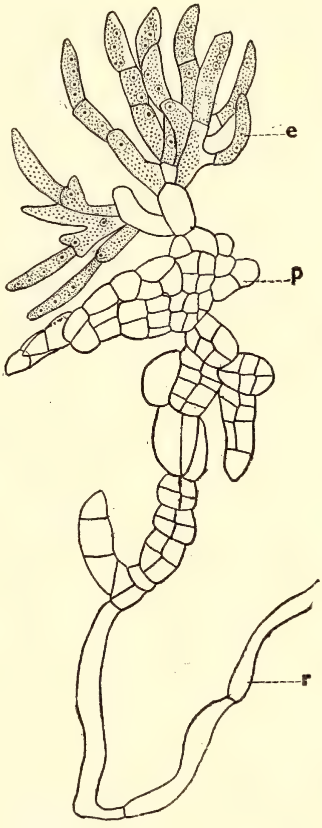

fig.

e = Erect system.
p = Prostrate system.
r = Rhizoidal system.

Singh's (1941) results of the analysis of soils showing low water content, less organic content, little reductivity, variation in pH may be attributed to the nature of the two different types of habitats in which the alga grows. From the results of the table, it can be concluded

ANALYSIS OF SOIL SAMPLES

Collected from the various spots around the temporary pond

TABLE

Sample Number	Colour	Texture	% Moisture content	% Organic content	Carbonate content	Reductivity		Nitrate content	pH	Remarks
						Without adding H_2O_2	After adding H_2O_2			
East 1 ...	Blackish	Clayey	11·90	2·62	−	−	++	+	7·5	Alkaline
East 2 ...	,,	,,	9·30	2·10	−	−	++	+	7·0	,,
East 3 ...	,,	,,	14·12	2·28	−	−	+	++	8·5	,,
West 1 ...	,,	,,	14·48	3·12	+	−	++++	++++	7·0	,,
West 2 ...	,,	,,	23·12	3·68	+	−	+++	+++	7·0	,,
West 3 ...	,,	,,	24·70	5·88	+	−	+++	++	7·5	,,
North 1 ...	,,	,,	15·62	6·43	−	−	+++	+	6·5	,,
North 2 ...	,,	,,	15·70	5·71	−		+++	++	7·5	,,
North 3 ...	,,	,,	16·32	6·21	−	−	+++	+++	7·0	,,
South 1 ...	,,	,,	13·30	9·01	+	−	+	++++	8·5	,,
South 2 ...	,,	,,	14·10	5·30	−	−	+	++++	8·5	,,
South 3 ...	,,	,,	9·22	4·82	−	−	++	++	8·0	,,

that *Fritschiella tuberosa* Iyeng. also grows in soils having appreciable amount of moisture content, organic content and nitrate content. In vegetative structural details the present investigation is in complete agreement with the observation of Singh (1941).

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr. B. N. Mulay, Professor and Head of the Department of Botany, Birla College, Pilani, and to Professor B. V. Ratnam, Department of Botany, Jaswant College, Jodhpur, for their keen interest and encouragement in the work.

DEPARTMENT OF BOTANY,
BIRLA COLLEGE, M. C. JOSHI
PILANI (RAJASTHAN),
June 8, 1957.

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24. A CATERPILLAR-PARASITING FUNGUS

Lt.-Col. F. M. Bailey in NO PASSPORT TO TIBET, page 196, while describing conditions at Kambado Drok, 15,700 ft., says 'On the pass the coolies found caterpillars with the parasitic fungus *Cordiceps sinensis* growing from their heads. I had seen them once before near Batang. The descriptive Tibetan name for the parasite and its host is Yartsa Gumbu, which means 'Summergrass Winterinsect'.

The genus *Cordiceps* is a fungus that belongs to the Scolecosporeae, and includes about 200 species distributed throughout the world. Most of them attack dead insects of various kinds, and only form perfect fructifications on substrata rich in proteins, such as the cadavers of insects. The fungus infects the insect through 'hyphae' or slender fungal vegetative strands; the insect is soon mummified, thereafter the fungus proceeds to form reproductive bodies, which in some tropical forms assume bizarre shapes and sizes. It is these reproductive bodies which are exported from China and Japan in the dry condition, and said to be a good tonic and vermifuge.

A similar group of fungi, the Laboulbeniales, is of interest in that such fungi only form their fructifications on the chitinous cover of *living* insects; these fungi, however, do not cause the destruction of the insect. On the other hand some species of *Entomophthora* attack the living insect and soon plug all its breathing pores and tubes, thus causing the death of the insect. Some such fungus seems to be the basis of some of the commercial methods of destroying termites or white ants; the method, to judge from the results obtained, is successful, but at the same time it remains a secret carefully guarded by the firms engaged in the protection of buildings against white ants.

BOMBAY NATURAL HISTORY SOCIETY,
114 APOLLO STREET,
BOMBAY 1,
September 20, 1957.

EDITORS

Fish Respond to New Bait

Inshore fishermen are reaping an unusual harvest with a new kind of bait which is cheap and lasting. The skipper of an inshore vessel which landed its catch at Grimsby yesterday said: 'We have found that by baiting our hooks with small pieces of rubber we are now catching, in addition to the usual cod and haddock, large quantities of fish known as coalie, which belongs to the cod family, and is very popular. This type of fish has never before responded to line fishing. The rubber remains on the hooks after the fish are caught and can be used for an almost indefinite period'.

From *The Times* (London) June 13, 1957.

Lake Victoria Mud Rich in Food Value

Mud from the bottom of Lake Victoria in Central Africa is rich enough in protein and minerals to be used, when dried, as hog and chicken feed, according to Government scientists.

The finding has emerged from a long-term survey of the fish potential of Lake Victoria. Researchers of the East African Fisheries Organization found that the absence of plankton, the minute organisms on which fish feed, was due to the scarcity in the water of the sulphur necessary for plankton growth.

Sulphur is normally released from mud by bacterial and chemical action. The observation that it was missing in the material from the bottom of Lake Victoria led to an analysis of the mud.

The researchers found little evidence of decomposition in layers of about thirty or forty feet in depth in which were locked the accumulated organic riches of thousands of years. The samples contained unusually huge amounts of sulphates, nitrogen and other plant nutrients.

Experiments have shown that the mud begins to decompose when dried. It has been suggested that it be dredged from the floor of the lake and spread over the adjacent swampy land.

R. S. A. Beauchamp, an investigator from the Government Research Station at Jinja, Uganda, on the northern shore of the lake, is convinced that large quantities of the mud could be used as hog and chicken feed. He had tasted it, he said, and found the mud 'quite palatable'.

From *The New York Times*, February 20, 1957.

NOTES AND NEWS

Col. R. Meinertzhagen is collecting information on the predatory or piratical habits of all birds whether crows, shrikes, hawks, skuas etc. and would be grateful for details of any exceptional or remarkable cases which have been observed. He does not want anything relating to recognised or normal procedure. He hopes to publish these records in book form later on. Full acknowledgement will be given to contributors.

Col. R. Meinertzhagen's address is 17 Kensington Park Gardens, London, W. 11.

* * * *

The 12th International Ornithological Congress will be held in Helsinki (Finland) from 5 to 12 June, 1958. In addition to the reading of scientific papers, discussions, showing of films, and other academic and social activities, two one-day excursions to places of ornithological interest will be arranged. Also before and after the Congress (31 May to 4 June, and 13 to 24 June) excursions will be arranged to representative places in the country.

The Congress fee is 3,000 Finnish marks for those who want the Proceedings of the Congress, otherwise 1,000 Finish marks.[1] The prospectus containing registration form and detailed information regarding hotels, cost of excursions, etc. is now available. Applications to attend the Congress, and to contribute scientific papers, should be sent in before 28 February, 1958 to the General Secretary, 12th International Ornithological Congress, University, Helsinki, Finland.

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[1] £1 = 865 Fmk.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31st DECEMBER 1956

President

Dr. Harekrushna Mahtab, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Mr. Sálim Ali

Executive Committee

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Mr. J. A. Singh, I.F.S.	
Mr. G. V. Bedekar, I.C.S.	*Bombay*
Prof. F. R. Bharucha, D.SC., F.N.I.	
Mr. R. E. Hawkins	
Dr. C. V. Kulkarni, M.SC., Ph.D.	
Mr. D. N. Marshall	
Mr. D. J. Panday	
Mr. D. E. Reuben, I.C.S. (Retd.)	
Mr. Humayun Abdulali (*Hon. Secretary*)	
Mr. M. J. Dickins (*Hon. Treasurer*)	

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S.	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Assam*
Col. R. C. Morris, F.R.G.S., F.Z.S.	*Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	*Nilgiris*
Dr. Baini Prasad, D.SC.	*Dehra Dun*
Dr. M. L. Roonwal, M.SC., Ph.D., F.Z.S.I., F.N.I.	*Calcutta*

List of members of the Executive and Advisory Committees elected for the year 1957 :

President

Shri Sri Prakasa, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Mr. Sálim Ali

Executive Committee

Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I. ...	*Poona*
Mr. J. A. Singh, I.F.S.	
Dr. D. V. Bal, M.Sc., Ph.D.	*Bombay*
Mr. G. V. Bedekar, I.C.S.	
Mr. R. E. Hawkins	
Dr. C. V. Kulkarni, M.Sc., Ph.D.	
Mr. D. N. Marshall	
Mr. D. J. Panday	
Mr. D. E. Reuben, I.C.S. (Retd.)	
Mr. Humayun Abdulali (*Hon. Secretary*) ...	
Mr. M. J. Dickins (*Hon. Treasurer*)	

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Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
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Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Assam*
Col. R. C. Morris, F.R.G.S., F.Z.S.	*Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	*Nilgiris*
Dr. Baini Prasad, D.Sc.	*Dehra Dun*
Dr. M. L. Roonwal, M.Sc., Ph.D., F.Z.S.I., F.N.I. ...	*Calcutta*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1956

THE SOCIETY'S JOURNAL

Parts 3 and 4 of Vol. 53 and Part 1 of Vol. 54 were published during the year under review.

MAMMALS

In 'Hedgehogs of the Desert of Rajasthan, Part II—Food and Feeding Habits' observations made on captive and semi-captive hedgehogs are reported by Daya Krishna and Ishwar Prakash.

M. A. Wynter-Blyth's 'The Lion Census of 1955' is a report on the second census of Gir lions held between April 11th and 14th, 1955. The author first gives an account of the recorded mortality among the lion population in the Gir between 1950 and 1955. This is not significantly high, and the present census carried out on lines similar to the earlier one in 1950 [Vol. **49** (3): 456-467] shows a total of 290 animals as against 224. This increase is bound to bring up other problems, especially about their food. Though there is no evidence of any decrease in the other game animals in the forest, the lions keep to the vicinity of villages and *nesses* and domestic cattle continue to form the major portion of their food.

BIRDS

Six papers were published under this head.

In 'A Contribution to the Ornithology of Garhwal' K. S. Lavkumar records 135 species from three hitherto little worked valleys in eastern Garhwal. Field observations and ecological notes are given for some birds.

'The Malayan Great Tit' by James Cairns is an account of the natural history of a very rare endemic race, *Parus major ambiguus*, at present known only from a narrow strip of mangrove forest on the west coast of Penang Island. The present population is estimated to be between 350 and 700 pairs. Other observations include notes on their food and feeding behaviour, breeding seasons, and nidification.

In 'Notes on the Baya Weaver Bird, *Ploceus philippinus* Linn.' Sálim Ali and V. C. Ambedkar discuss the breeding biology of the Baya, a paper based on observations made during three seasons, June to October 1953-1955, in two colonies, one in the Bombay area and the other in Poona. The observations throw some light on hitherto little known facts regarding the life and movements of the Baya during the breeding season and provide some statistical data relating to nesting behaviour, etc. Marking of the Bayas was undertaken with dyes as well as with coloured and aluminium rings. Notes on the sex ratio, abnormal nests, intelligence, and natural enemies and mortality rate are included.

F. N. Betts records 170 species with field notes in an article entitled 'Notes on Birds of the Subansiri Area, Assam'. The list covers about 30 per cent of the species which occur in the area, where the author spent about eighteen months making field observations and occasional collections.

Prof. J. Berlioz has given a brief account of the natural history of 'Sunbirds and Humming-birds', two fascinating groups containing some of the smallest and most brilliantly coloured birds in the world. The convergent resemblance of the sunbirds and humming-birds has in the past caused considerable confusion in their taxonomy. The sexual dimorphism, food and habits, habitats and geographical distribution, and relationships of these birds are discussed.

'The Whitebellied Sea Eagles of Karwar [*Haliaetus leucogaster* (Gmelin)]' by R. S. Dharmakumarsinhji and K. S. Lavkumar recounts observations made during six days in January 1956, at the Oyster Rocks off Karwar, on the habits and behaviour of a pair at a nest containing well-fledged young.

C. E. Hewetson in 'Observations on the Bird Life of Madhya Pradesh' gives a list of 308 species and races with notes on the status and habitat, general habits, voice, and nesting of many of them. Notes kept on the migrants have helped to give an idea of the general pattern of bird distribution in a large part of central India. The author recognises five major habitats or biotopes, and a list of the species one is likely to come across in each is mentioned.

REPTILES AND AMPHIBIANS

No papers were published, but it is encouraging to find an increase in the number of Miscellaneous Notes on this group. They indicate possibilities for further work in Herpetology, and it is hoped that there will soon be more response from students and naturalists who have the opportunity.

FISH AND FISHERIES

Three papers were published in this section.

In 'Kashmir—A Fishing Holiday' the late A. St. J. Macdonald writes of the problems that an angler has to confront when visiting Kashmir. Mr. Macdonald has given an itemised account of what to do and where to go, together with details of formalities of travel and notes on fishing, beats, expenses, etc., which every angler intending to visit Kashmir should study for the fund of useful information it contains.

The late Dr. S. L. Hora in 'Some Observations on the Trout Farm and Hatchery at Achhabal, Kashmir' has reviewed the stock position in the hatchery and discussed at length diseases and other causes of mortality. Fungus infection, lipoid degeneration of the liver, blindness and depredation by otters are given as primary factors causing heavy mortality, while other minor factors are also discussed. A section is devoted to the food and growth of trout fingerlings, and several recommendations and suggestions for the improvement of the hatchery are made.

In an account on the 'Fishes of Kolhapur' K. N. Kalawar and C. N. Kelkar list 71 species as occurring in the district. The local Marathi names of most of them are given with descriptive notes on certain species. *Botia striata* var. *kolhapurensis* is described as a new race.

INVERTEBRATES

The following papers were published in this section:

Nematoda:

'Marine Nematodes from the Bay of Bengal—I. Phasmidea' by Richard W. Timm contains the descriptions of one new genus, two new species, and one new variety of marine nematodes, obtained from Sonadia Island, Bay of Bengal, and Cox's Bazar, East Pakistan. The section on 'Discussion' under each species and variety, besides dealing with nomenclatorial clarifications, includes certain observations on the ecology of these little known worms.

Arthropoda:

Insecta: Ten papers were published during this period.

D. G. Sevastopulo's 'Notes on the Heterocera of Calcutta. Parts I, II and III' are based on a series of collections made by him in Calcutta between 1930 and 1946. Records of monthly occurrences are given for the 1945-1946 period. The author believes that the use of a Mercury Vapour light for trapping purposes would have considerably augmented his list.

A. P. Mathews has given a detailed account of the post-embryonic development of *Machaerota noctua* Dist. (Insecta : Homoptera : Cercopidae). The successive stages in the life-history of *M. noctua* are traced and the relations of the instars to the tubes in which they live discussed. The role of the 'Primary' and 'Secondary' tubes in which the life cycle is completed is explained dispelling the earlier view that the narrow short primary tube was meant probably only for aeration.

A study of the copulation in 16 species of Shorthorned Grasshoppers has enabled K. N. Katiyar to classify them mainly under three modes (riding mode, lateral mode, and hanging mode), with a few showing intergradation with one or the other. These are described in the article entitled 'Modes of Copulation in Shorthorned Grasshoppers (Orthoptera : Acrididae)'. The study suggests that some correlation exists between the relative body-lengths of the two sexes and the mode of copulation adopted.

In 'Bionomics of the Pumpkin Caterpillar—*Margaronia indica* Saund. (Pyralidae : Lepidoptera)' R. C. Patel and H. L. Kulkarny discuss the habits and life-history of an important pest of cucurbitaceous vegetables, the caterpillars of which cause considerable damage to the leaves and fruits. The number of instars varies from 4 to 5 and the rate of feeding is greatly accelerated during the three days prior to prepupal stage.

F. L. Wain in 'Notes on Some Wasps and Bees (Hymenoptera) from Poona and the Western Ghats' records 85 species collected at different times during a period of five years. The article is well illustrated and contains field notes on the habits of certain species and remarks on the sexes.

In 'Differential Response to Forms and Pattern in two Species of Indian Honeybees' K. K. Dixit throws more light on the fact that, as in the case of European Honeybee *Apis mellifera*, a pattern which presents a greater contour is spontaneously preferred to one with less, both by *A. indica* and *A. florea*. Experiments point to the fact that the distance at which the bees make their choice between alternate patterns varies for different species. The results thus far obtained seem to suggest that *A. florea* may have a slightly greater visual acuity than *A. indica*.

A brief account of 'Some Beneficial Coccinellids of Mysore' by M. Puttarudriah and C. P. Chenna Basavanna deals with 25 species and their host-plants.

In 'Further Observations on the Biology of the Common 'Tree-hopper' *Otinotus oneratus* Walk. (Homoptera: Membracidae) in Orissa' U. C. Panda and B. K. Behura give an account of the bionomics of the species based on observations made at Balasore and Cuttack, Orissa, during 1952-1953. 15 new host-plants of this membracid are listed.

Arachnida: In 'Bionomics of the Giant Wood Spider, *Nephila maculata* Fabr.' M. K. Thakur and V. B. Tembe have dealt with the largest orb-weaving spider in India. Sexual dimorphism, mating, and breeding habits are given in fair detail, and it is shown that the spider has five types of silk glands, the secretion of each having a specific use. The authors have classified the silk produced by the spider according to its nature and use. This study was conducted with the help of a grant made by the Bombay Natural History Society.

'Biology of the Scorpions' by Max Vachon, a much appreciated, widely read and profusely illustrated article, was reproduced from *Endeavour*, Vol. XXII (46), April 1953 with the kind permission of its publishers. In its present form it contains some additional notes by Dr. A. P. Mathew, of Kerala University. Scorpions, which may even be termed 'living fossils', attained a high degree of perfection early in their evolutionary history and have remained unchanged for hundreds of millions of years. The complexity of their digestive processes, carried on partly outside the body, the mode of nutrition of the embryo, the complex system of sensory hairs, the elaborate nuptial dances, and their evolutionary significance are all discussed here.

BOTANY

In 'Geographical Distribution of the Halophytic Plants of Bombay and Salsette Islands' B. S. Navalkar discusses the distribution of the mangrove vegetation, which is chiefly composed of *Avicennia alba*, a prolific grower. Six categories of halophytic plants are recognised on the basis of their nearness to the sea and the consequent richness in sodium chloride content of the soil. A comparison of the number of halophytes of Bombay and Salsette Islands is made with those of the Sunderbans, the Malay Peninsula, and South Africa.

'Indian Marsileas: Their Morphology and Systematics' by K. M. Gupta and T. N. Bhardwaja is a review of the systematic position of the Indian species based on the structure and disposition of the sporocarp. A key to their identification with brief accounts of the morphological nature of the vegetative parts and sporocarp are given.

J. N. Misra ('A Systematic Account of some littoral marine Diatoms from the W. Coast of India') lists 69 forms of littoral and benthic diatoms from the west coast of India. Of these 45 are epiphytic on various higher algae and 24 occur in sediments.

In 'New Plant Records from South India-I' D. D. Sundararaj gives six new distributional records.

'Botanical Exploration in the Bhillangna Valley of the erstwhile Tehri Garhwal State' by Raj Kumar Gupta is based on observations made during trips to Masar Tal Lake (10,000 ft.) and collections from Sahsru Tal Lake (16,000 ft.) made in the months of May and September, and supplemented by observations at Naini Tal and Mussoorie. Three climatic zones are recognised. The vegetation of the area is described zonally with an annotated list of species collected in each zone.

In 'Chapters on the History of Botany in India, II. The Advances and in particular the Plant Collecting of the Thirties and Forties of the 19th Century' I. H. Burkill reviews a period marked with considerable activity both in botanical explorations and in the publication of papers and monographs on Indian botany through the medium of many new scientific journals which came into being during this period. The progress achieved through the untiring efforts of

Wallich, Griffith, and a score of other enthusiasts was such that, besides mere taxonomic work, a beginning was possible at this time in other aspects such as plant ecology and phytogeography.

'Vegetation of Pilani and its Neighbourhood' by W. C. Nair and G. S. Nathawat is in part a revision of an earlier list published under the same head by Bakshi [*JBNHS*, **52**: 484-514, 1952]. In addition, the authors list with field notes 145 species, the distribution of which is now extended to this area.

In 'Some useful Weeds in and around Cuttack' H. Pattnaik reports on a preliminary survey in which 14 species of useful weeds were collected. Notes on the uses of the weed, flowering period, and habits are given for each species along with their local Oriya names.

Wild Life

Col. K. Guman Singh's article 'Game Preservation in Jammu and Kashmir State' forms in part an addendum to the report of the Society's delegation on 'Game Preservation in Kashmir' published in Vol. 53 (2) of the *Journal*. The author concludes by advocating the introduction of certain exotic game animals and birds, a controversial subject on which opinion has long been widely divided but has now crystallised as definitely against.

In 'Ducks Unlimited: and Wild Life Preservation in Ceylon', Philip K. Crowe draws attention to the urgent need to save what is left of Ceylon's greatly depleted wild life from complete extermination. As an instance of achieving the impossible, he cites the case of the remarkable recovery of the American duck population through the co-operation of the sportsmen and the public, in spite of the ever-increasing number of hunters in that country. Many of his remarks and suggestions concerning Ceylon are equally applicable to India.

Part III of E. P. Gee's 'The Management of India's Wild Life Sanctuaries and National Parks' is a timely contribution. It draws attention to the great need for the formation of more National Parks and Wild Life Sanctuaries, not only for the protection of our fauna and flora from increasing human depredations, but also as attractions for tourists and a consequent means of earning foreign exchange. The rapidly increasing human population with the demand on land for settlement, cultivation, and grazing, presents a grave problem in certain parts of the country where encroachments into some of the existing Wild Life Sanctuaries have already taken place. The author rightly contends that in addition to their aesthetic and scientific value, good Wild Life Sanctuaries are of great economic value to the country, and should not merely serve as areas to be later opened up for settlement or grazing.

Miscellaneous Notes

116 notes covering all branches of natural history were published. This section of the *Journal*, as usual, is very popular with readers,

but of late there has been a tendency to a decrease in the contributions received. If this indicates a trend towards flagging interest in field observations etc., it needs rectification. Contributions from members and others interested in natural history are most welcome.

NATURE EDUCATION

The Society's efforts at Nature Education in schools, financed by the Government of Bombay, is now in its tenth year. Its main aims are the popularisation and promotion of interest in natural history among children and teachers and the publication of well-illustrated and inexpensive booklets on nature study.

In the series 'Glimpses of Nature' OUR BIRDS Book No. 2 was published in English, Marathi, and Hindi, and the third booklet on OUR BEAUTIFUL TREES is in the press.

The usual activities included guided tours of the Natural History Section of the Prince of Wales Museum, the Taraporevala Aquarium, and the Victoria Gardens. Four field-trips were arranged for members of the Nature Study Clubs and a large number of students participated. Two special field-trips were arranged for teachers, one to Elephanta Island and the other to Tulsi Lake. Many of the children were keenly interested.

The All India Radio arranged two talks on 'Nature Rambles' by the Nature Education Organiser. These were broadcast in English, Marathi, and Gujarati.

Special talks on 'Wild Life Preservation', illustrated by slides and films, and on 'Insect Life' and 'Evolution', with the aid of exhibits, were arranged for children.

GENERAL

In addition to the nature films shown at the Annual General Meeting on 22-8-1956, the Society arranged for a lecture on 'The Study of Pollen (Palynology)' by Professor G. Erdtman of the Palynological Laboratory, Stockholm, at St. Xavier's College, on 7th December 1956.

Much useful field work had been carried out under the grants made with the assistance of the Sir Dorabji Tata Trust, and we hope soon to publish reports thereon in the *Journal*.

PUBLICATIONS

BUTTERFLIES OF THE INDIAN REGION by M. A. Wynter-Blyth, though again delayed, is making progress and there is every hope of its publication early next year.

The publication of the 'Wall Chart for the Identification of Poisonous Snakes' is also in hand.

REVENUE ACCOUNT

Total receipts during the year amounted to Rs. 49,373, which includes grants of Rs. 4,000 each from the Government of India and the Government of Bombay, as compared with Rs. 51,791-4-3 during the previous year.

Sales of some of the Society's publications and also back numbers of the *Journal* were appreciably higher than last year.

The following is a comparative statement showing the different sources of Revenue in 1955 and 1956:

	Revenue in 1955	Revenue in 1956	Increase in 1956	Decrease in 1956
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A P.
Subscriptions ...	20,428 0 0	21,303 0 0	875 0 0	——
Entrance Fees ...	1,372 0 0	1,589 0 0	217 0 0	——
Publications:				
Books ...	10,210 0 0	9,677 0 0	——	533 0 0
Journals ...	3,320 0 0	4,421 0 0	1,101 0 0	——
Sundries, Taxidermy, Advertisement, etc.	352 0 0	341 0 0	——	11 0 0
Interest on Investments	4,109 0 0	4,042 0 0	——	67 0 0
Grants:				
Govt. of India ...	8,000 0 0	4,000 0 0	——	4,000 0 0
Govt. of Bombay ...	4,000 0 0	4,000 0 0	——	——
Total ...	51,791 0 0	49,373 0 0	2,193 0 0	4,611 0 0

The total number of members on our books on 31st December 1956 was 1187 of whom 232 are Life Members. Subscriptions for 1956 have so far been received from 710 members. During the year, 61 new members joined while 3 Life Members, 1 Honorary Member, and 5 Ordinary Members died, and 15 resigned.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr. P. M. D. Sanderson who continues to look after the Society's interests in the United Kingdom.

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST 1957

A report of the activities of the Society up to 31st December 1956 is already in your hands and I will make a few remarks on those during the current year.

The long-delayed Butterfly Book is now ready and some progress is being made with the second edition of THE BOOK OF INDIAN ANIMALS. The wall chart for the Identification of Poisonous Snakes is also in hand, but we have run into unexpected difficulties in procuring suitably large types for printing the editions in Gujarati and Marathi.

The Society has long felt the want of a whole-time worker at the office, and during the year, pending finalization of the revised agreement with the Museum, we have appointed Dr. E. G. Silas as Registrar. It is hoped that with his assistance it will be possible to render more useful service to members not only in Bombay but also those resident outside.

I may perhaps take this opportunity of expressing regret that relatively few members take advantage of our library and such other facilities as the Society is able to offer. There are a large number of old books on travel, exploration, shikar and other forms of field sport. Last year 60 members borrowed 250 books while about 100 have been issued to 25 members so far during this year. In addition to this, students from the Institute of Science, the Taraporevala Aquarium and other scientific institutions visit the library for referring to books and scientific journals, many of which are unavailable elsewhere.

There is some cause for optimism that our application to the Central Government for a building grant to house the offices and the reference collections is being sympathetically considered, and it is hoped that as soon as this is achieved it will be possible for the Society to be of more active usefulness to students of various forms of animal life.

In the last report I referred to a grant of Rs. 3,000 received from the Sir Dorabji Tata Trust, for field work in natural history. This was distributed among 7 applicants who have been enabled to carry out useful work. Some of the reports, we hope, will be published in future issues of the *Journal.*

We have also been able to arrange, through the interest of Dr. W. H. Thorpe of the Cambridge University Zoological Museum, for Mr. J. H. Crook, at present engaged in post-graduate studies at Cambridge, to visit India for a period of two years to carry out field studies on the social organisation of the Bayas or Weaver Birds. He will be working with Mr. Sálim Ali who commenced these studies several years ago. The cost of Mr. Crook's visit will be met by Dr. Thorpe from a grant from the Department of Industrial and Scientific Research in the United Kingdom. While engaged in this work it is hoped that Mr. Crook will have close contacts with many local zoology students and teachers, and enable them to under-study him in modern techniques—and later to initiate research in field and economic ornithology, a subject of great importance to agriculture and forestry but on which almost no work has been done in this country. I hope to be able to comment on the progress of Mr. Crook's work more fully in my next report.

During the current year 34 members joined. It has been suggested to us that the entrance fee of Rs. 25 may possibly act as a deterrent to many individuals from joining the Society although we have, for some time, offered to accept this sum in instalments spread over a period of five years. Thus, as an experimental measure, the Committee has now decided to accept new members for a nominal lump-sum entrance fee of Rs. 5. It is hoped that this will induce many people on the border-line of decision to make up their minds and lend their support to the Society.

Over the last 10 years the number of members actively interested in birds and animals and other forms of wild life in the field has unfortunately declined, as reflected in some measure by the rather more technical nature of the contributions appearing in the *Journal* of late. The editors are endeavouring to retain and resuscitate popular interest in a number of ways, but it must be realized that in the main the *Journal* must be what its contributors make it. Unless members in India avail themselves of the matchless opportunities for field study and observation which lie almost on their doorstep, and contribute original and interesting popular articles and notes on natural history and sport, there is bound to be an increasing but unavoidable tendency for the *Journal* to get more and more technical, or 'dry-as-dust' for the average reader.

The following 61 members have joined since the last Annual General Meeting:

FROM 16TH AUGUST TO 31ST DECEMBER 1956

Mr. D. H. Fordham, Rajahmundry; The President, Mess Committee, 1st Bn., The Para Regt. (Punjab), Agra Cantt.; The Principal, A.M.A.L. College, Anakapalle; Mr. K. Rajgopal, Kovilpatti; Bombay Presidency Angling Association, Bombay; Mr. Hans Ragnar Edberg, Sweden; Dr. H. N. Maniar, Bombay; Mrs. B. H. Pease, Bombay; Mr. Samir Sen, Darjeeling; Mr. N. J. Northover, Bombay; The Principal, Government College, Ludhiana; Mr. Z. J. Kapadia, Bombay; The Principal, Agricultural College, Bapatla; Mr. J. H. H. Peppe, Basti; The Principal, Agricultural College, Muzaffarpur; Mr. Tribeni Prasad Singh, Bhagalpur; Mrs. Swarna Subramaniam, Madras; Mr. John R. Whitehead, E. Pakistan; Mr. J. Cairns, Penang; Prof. D. V. Bal, Bombay; Jardin Botanique de L'Etat, Belgium; Miss D. P. Panthaki, Bombay; Dr. Harold Trapido, Poona; Mr. S. R. Choudhary, Orissa; The Principal, Meerut College, Meerut; Lt.-Col. T. Barrington, New Delhi.

FROM 1ST JANUARY TO 15TH AUGUST 1957

Mr. Onkarnath Dwivedi, Calcutta; Dr. D. K. Lahiri Choudhary, Orissa; The Hon'ble Mr. Felix Standaert, Bombay; Mr. A. J. Sharman, Madras; Bharatiya Vidya Bhavan, Bombay; Regional Botanist, Botanical Survey of India, Shillong; Botanical Survey of India, Southern Circle, Coimbatore; Mr. G. H. Mansell, Kerala State; Mr. Julian P. Donahue, Kodaikanal; Mrs. T. A. Fairfield, Assam; St. Xavier's College, Palamcottah; Government College, Chittur, Cochin; Mrs. Laprelle Edens, California, U.S.A.; Mrs. Ralph B. Weidman, Bombay; Botanical Survey of India, Western

Circle, Poona; Mr. A. M. G. Brown, Bombay; Officer-in-Charge, Naval Chemical and Metallurgical Labs., Bombay; Shri Sri Prakasa, Governor of Bombay; Mir Liaquat Hussain, Nizamabad; H. H. The Raja Sahib of Nandgaon; Mr. H. T. Joshi, Bombay; Commandant, College of Military Engineering, Poona; Prof. V. V. Apte, Poona; The Honorary Secretary, High Wavys Club, Madras; Sq. Ldr. D. S. Majithia, Gorakhpur; Mr. A. M. Morgan-Davis, Ceylon; The Hon'ble Mr. Henri Dumont, Bombay; Dr. P. Legris, Pondicherry; The Chief Forester, Nepal; Prof. Laurent Schwartz, France; St. Xavier's College, Ranchi; Mr. R. P. N. Sinha, Delhi; Mr. C. A. Lister, Bombay; Lt.-Col. Ina Shumshere J. B. Rana, Kathmandu, Nepal; Mr. Beryl de Zoete, London.

HUMAYUN ABDULALI
Honorary Secretary.

THE BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT 31st DECEMBER 1956

FUNDS AND LIABILITIES		Rs A P	Rs A P
Trust fund or Corpus:			
Life Membership Fund.			
Balance as per last Balance Sheet ...		95,089 9 8	
Add: Amount received during the year ...		300 10 8	95,390 4 4
Other Earmarked Funds:			
Expedition Fund.			
Balance as per last Balance Sheet		1,800 0 0	
Field Work Fund.			
Balance as per last Balance Sheet	2,956 7 0		
Less: Expenses during the year	2,341 12 3	614 10 9	
Wild Life Fund.			
Balance as per last Balance Sheet	1,000 0 0		
Less: Expenses during the year	284 12 0	715 4 0	
Mammal Survey Fund.			
Balance as per last Balance Sheet		3,627 8 4	
Reserve for future Publications		33,020 0 0	39,777 7 1
Liabilities:			
For Expenses		29,773 1 4	
,, Advances (Subscriptions and Entrance Fees)		1,447 8 11	
,, Rent and Other Deposits... ...		Nil	
,, Sundry Credit Balances ...		4,023 15 9	35,244 10 0
Carried forward ...			1,70,412 5 5

ASSETS	Good	Doubtful	Rs A P	Rs A P
Immovable Properties:				
Investments:				
Rs. 14,000 4% Bombay Port Trust Bonds			10,780 0 0	
,, 15,000 4% Bombay Improvement Trust Bonds ...			11,400 0 0	
,, 36,000 3% Funding Loan 1966-68			35,812 10 0	
,, 25,000 3% Conversion Loan 1946			25,000 0 0	
,, 2,000 3% First Development Loan 1970-75 ...			1 948 12 0	
,, 92,000 (Market value on 31st December 1956 Rs. 81,978-12-0)			84,941 6 0	
£460 3½% Defence Bonds			6,133 5 4	
			91,074 11 4	
Less: Provision for Depreciation ...			2,750 0 0	88,324 11 4
Furniture and Fixtures:				
Balance as per last Balance Sheet ...			2,187 8 0	
Less: Depreciation for the year ...			273 7 0	1,914 1 0
Loans: (Secured):				
Loan Scholarships ...	Nil	Nil		
Other Loans (to staff) ...	230-0-0	,,		230 0 0
Advances:				
To Trustees			Nil	
,, Employees			,,	
,, Contractors			26,354 1 6	
,, Lawyers			Nil	
,, Others			200 0 0	26,554 1 6
Income Outstandings:*				
Rent			Nil	
Interest			,,	
Other Income:			Nil	
Supplies and Services			6,421 2 3	
Government of Bombay (Grant)			4,000 0 0	10,421 2 3
Carried forward ...				1,27,414 0 1

*The accounts for interest received are maintained on a cash basis. The interest outstanding as at 31-12-1956 amounts to Rs. 1,426-10-6.

BALANCE SHEET AS AT 31st DECEMBER 1956—(*continued*)

FUNDS AND LIABILITIES	Rs A P	Rs A P	ASSETS	Rs A P	Rs A P
Brought forward ...		1,70,412 5 5	Brought forward ...		1 27,444 0 1
Income and Expenditure Account:			*Stock of Books on hand:*		
Balance as per last Balance Sheet ...	52,349 2 9		At cost or under, as certified by the Honorary Secretary		56,849 12 0
Less: Deficit as per Income and Expenditure Account	4,709 2 4	47,640 0 5	*Cash and Bank Balances:*		
			(*a*) 1. *In Current Account with:*		
			National Bank of India, Ltd., Bombay	6,283 3 0	
			National Bank of India, Ltd., London (£143-12-7)	1,915 0 9	
			2. *In Fixed Deposit Account with:*		
			National City Bank of New York, Bombay	25,210 6 0	
			(*b*) With the Trustee	Nil	
			(*c*) With the Cashier	350 0 0	33,758 9 9
Total ...		2,18,052 5 10	Total ...		2,18,052 5 10

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Property and Assets of the Trust.

BOMBAY, *8th May 1957.*

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31st December 1956

Receipts	Rs	A	P	Payments	Rs	A	P
To Grant from Government of Bombay	6,100	0	0	By Balance due to the Society as per last Balance Sheet	2,773	7	9
,, Publication Grant Account from Government of Bombay	5,000	0	0	,, Cost of Nature Study Pamphlets and Books	2,425	7	3
,, Nature Study Pamphlets and Books Sales	2,837	5	9	,, Salary of Nature Education Organiser	5,370	0	0
, Bombay Natural History Society (Advance)	7	13	6	,, Publication Grant Account	157	11	3
				,, General Expenses (Stationery, Conveyance, etc.)	159	15	9
				,, Postage	138	2	0
				,, Bank Balance	2,920	7	3
Total ...	13,945	3	3	Total ...	13,945	3	3

Bombay; *8th May 1957.*

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE IX

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1956* Cr.

EXPENDITURE	Rs A P	Rs A P
To *Expenses in respect of Properties:*		
Rates, Taxes, Cesses, Repairs, and Maintenance	Nil	
Salaries	,,	
Insurance	,,	
Depreciation (by way of Provision or adjustments)	,,	Nil
,, *Establishment Expenses:*		
Salaries (including Dearness Allowance)	23,978 11 0	
Society's contribution to Staff Provident Fund	1,098 3 0	
Rent	2,400 0 0	
Postage	1,178 15 10	
Printing and Stationery...	980 10 0	
Editor's Travelling Expenses	1,200 0 0	
Advertisement	219 0 0	
Special Audit (Charity Commissioner's Purpose)	450 0 0	31,505 7 10
Remuneration to Trustees:		Nil
,, *Legal Expenses:*		Nil
,, *Audit Fees:*		250 0 0
,, *Amount written off:*		
Bad Debts	Nil	
Loan Scholarships	,,	
Irrecoverable Rents	,,	
Other items	,,	Nil
,, *Miscellaneous Expenses:*		
General Charges	1,437 13 5	
Fire Insurance	160 15 0	
Sales Tax	183 13 0	1,782 9 5
Carried forward ...		33,538 1 3

INCOME	Rs A P	Rs A P
By *Rent:* Accrued	Nil	
Realised	,,	Nil
,, *Interest (Realised):*		
On Securities	3,253 2 8	
,, Bank Account	789 8 0	4,042 10 8
,, *Dividend*		Nil
,, *Donations in cash or kind*		,,
,, *Grants:*		
Government of India	4,000 0 0	
Government of Bombay	4,000 0 0	8,000 0 0
,, *Income from other sources:*		
Subscriptions	21,303 1 2	
Entrance Fees	1,589 10 0	22,892 11 2
,, *Publications Profits:*		
Journal Sales	4,421 0 6	
Books etc.:		
Book of Indian Birds	2,696 3 5	
Book of Indian Animals...	1,628 0 2	
Some Beautiful Indian Climbers and Shrubs	784 13 2	
Some Beautiful Indian Trees	1,166 9 7	
Circumventing the Mahseer and other Sporting Fish	322 8 0	
Indian Molluscs	137 14 3	
Game Birds Vol. III	20 13 10	
Calendars	2,918 13 0	
Taxidermy, etc.	51 3 9	
Other Publications	89 15 9	14,237 15 5
,, Natural History award unutilised brought back to revenue account		200 0 0
,, Deficit		4,709 2 4
Carried forward ...		54,082 7 7

SCHEDULE IX—*(continued)*

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1956—(continued)* *Cr.*

EXPENDITURE	Rs A P	Rs A P	INCOME	Rs A P	Rs A P
Brought forward ...		33,538 1 3	Brought forward ...		54,082 7 7
To Depreciation :					
On Investments	1,750 0 0				
On Furniture	273 7 0	2,023 7 0			
To Expenditure on Objects of the Trust :					
(*a*) Religious	Nil				
(*b*) Educational—Journal Expenses ...	17,423 9 10				
Library	1,097 5 6				
(*c*) Medical relief, Relief of Poverty...	Nil				
(*d*) Other charitable objects ...	,,	18,520 15 4			
Total ...		54,082 7 7	Total ...		54,082 7 7

BOMBAY, *8th May 1957.*

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE CONFERENCE HALL OF THE B.E.S. & T. UNDERTAKING, ELECTRIC HOUSE, ORMISTON ROAD, BOMBAY, ON WEDNESDAY THE 21ST AUGUST 1957 AT 6 P.M. WITH REV. FR. H. SANTAPAU, S.J., IN THE CHAIR

1. A message from Shri Sri Prakasa, Governor of Bombay, regretting his inability to preside at the meeting due to illness was read.

2. The Honorary Secretary's Report for the year ended 31st December 1956, having been circulated, was taken as read. The Honorary Secretary then enumerated the activities of the Society during the period January to August 1957. (See pp. 985-988.)

3. The balance sheet and statement of accounts presented by the Honorary Treasurer were approved and adopted.

4. The Committee's nominations to the Executive and Advisory Committees, as previously circulated to members, were accepted by the meeting.

After conclusion of the formal business of the meeting, two films:

LONG FLIGHT, loaned by British Information Service and

WILD LIFE AND THE HUMAN TOUCH, loaned by the United States Information Service, were shown to members and their friends, and greatly appreciated.

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EDITORS: SALIM ALI, AND H. SANTAPAU
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Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS should preferably be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names, to be printed in italics, should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and sub-specific names always begin with a small letter even if they refer to a person or a place, e.g., *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri.*

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 3¼ × 2¼ inches (No. 2 Brownie) and on glossy glazed paper.

6. Text figures, line drawings and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Roepke, W. (1949): The Genus Nyctemera Hübner. *Trans. ent. Soc. Lond.* **100** (2): 47-70.

Prater, S. H. (1948): The Book of Indian Animals, Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Roepke, 1949).

9. *Synopsis*: As recommended by the Royal Society Scientific Information Conference (July 1948), the editors consider it desirable that each scientific paper be accompanied by a synopsis appearing at the beginning, immediately after the title. The synopsis should be factual. It should convey briefly the content of the paper; draw attention to all new information and to the author's main conclusions. It should also indicate newly observed facts, the method and conclusions of an experiment, and if possible the essential points of any new finding, theory or technique. It should be concise and normally not exceed 200 words.

When the synopsis is completed it should be carefully revised by the author to clarify obscurities, and further compressed wherever possible without detracting from its usefulness.

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EDITORS,
JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

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MAY 1961

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